MUNICIPAL IMPROVEMENTS.

A MANUAL

OF THE

METHODS, UTILITY, AND COST

OF

PUBLIC IMPROVEMENTS,

FOR THE

MUNICIPAL OFFICER.

BY

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TO MY FRIEND

The Honorable Frederick Schuette,—

A Merchant of Manitowoc, Wis.; twice successively
elected to the Mayoralty of that City;
an earnest, judicious Advocate of Municipal Improvements,
which are essential to public prosperity;
economical and progressive in the discharge of
his administrative duties,—
This work is respectfully dedicated by
THE AUTHOR.

PREFACE.

THE writer of this work has avoided to a certain extent the use of technical words and phrases, also mathematical tables and formulæ, because it is intended for the non-professional reader.

Once in every year throughout our broad land there are chosen, from among the citizens of every city and town, a number of councillors who will sit in the council chamber and assist the chief magistrate in the government of the municipality which they represent. The members of the council are perhaps familiar with the general plan and scope of the various public improvements contemplated during their administration, but of the details of the work proposed they are uninformed. It is in the nature of things that this should be so; their education and training have been in other work and its rewards. Yet, being men of affairs, they will not hesitate to seek such information regarding any proposed improvements as will enable them to discharge their official duties in a manner that will be commended by their constituents.

If the contents of this book can assist the prudent,

conscientious magistrate or councilloi to secure, in a judicious and economical way, those improvements which are essential to the welfare and prosperity of a municipality, the writer will believe that his aim has been good, although the arrow may fall short of the mark.

W. F. GOODHUE.

MILWAUKEE, WIS., October 13, 1892.

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A SEWERAGE SYSTEM.

A TOWN or city should have a sewerage system planned for its entire area, having in view at the time the work is done its prospective future population and enlarged area. It does not follow that because a plan is made for the whole city the entire system should be built at once; on the contrary, a sewerage system is never completed unless a city stops growing. When the main sewers are once built, the street sewers are put in street by street, a certain amount each year is laid, —just so much as the property owners on each street may petition for. Consequently the expenditures and growth of the sewer work of a city are almost entirely in the hands of the property owners. In fact, in some of our smaller cities the sewer work done is altogether too much in the hands of the property owner: he not only controls the laying of sewers, but dictates their course, depth, and outfall; and the result of it all is: there is a sewerage system for every two or three blocks, and

the banks of lake or stream are perforated with stinking outlets of sewers. After such work has once fairly begun in a town or city it is difficult for the council to check it; indeed it cannot be checked without causing some bitterness of feeling: the property owner resents the interference of the council with what he is pleased to term "the right of property owners to use the street." The only way to remedy this evil of private drain-laying in cities is for the council to immediately adopt the plans of a sewerage system and rigidly adhere to it in the future construction of sewers. Of course the property owners who have laid private sewers can most always be depended upon to oppose the adoption of the sewerage plans; they have taken care of their own sewage by emptying it upon a neighbor's premises, or at some place contiguous thereto, and decline to be taxed further for the benefit of this neighbor or of anybody else.

Sewers should not be built needlessly large, that is, of too great diameter: the larger the sewer the larger volume of water required to flush it. Besides, a large sewer running only one fourth full, or less, leaves a large space above the flow of sewage for the accumulation of gases, which will prevail unless the sewers are well flushed.

The sectional area of a sewer is generally rated for comparison, one diameter with another, by squaring the diameter of a pipe; as, for instance, a pipe 10 inches in diameter is (10×10 equals 100) represented by 100 square inches; a sewer 6 inches in diameter is (6×6

equals 36) represented by 36 square inches; and a rubber hose $2\frac{1}{2}$ inches in diameter is ($2\frac{1}{2} \times 2\frac{1}{2}$ equals $6\frac{1}{4}$) represented by $6\frac{1}{4}$ square inches. If you should flush a sewer 10 inches in diameter with a stream of water thrown from an ordinary fire-department hose, you would be using, relatively, $6\frac{1}{4}$ inches of water to flush 100 inches of pipe. It is not economical to lay sewer-pipe excessively large, and it is a worse economy to lay water-pipe too small in diameter; yet this is the order of construction desired in many places, when if they would reverse the conditions, i.e., smaller sewers and larger water-pipe, the service would be much better all around.

Nowadays there are two distinct systems of sewerage in use: one is known as the *combined* system, the other as the *separate* system.

The combined system requires the largest pipe, catch-basins at street corners, and pipe connections with the mains; also man-holes at street intersections, although man-holes are common to both systems; and it costs to build it about 70 per cent more than the separate system does.

The combined system is the one generally built in the largest cities; it receives and disposes of all surface (storm) water which flows in the street gutters and all the sewage from house, factory, and hotel.

The separate system has smaller pipe, because it receives no water from the street gutters; it has man-holes at the street intersections and oftener if required, but has no catch basins and receives all the sewage

from house, factory, and hotel. The actual difference between the two systems is that the former cares for the street water of a city and the latter does not. The use of the flushing tankis common to both systems. Where the combined system is used, the storm-water, falling upon the sidewalks and streets, washes their surfaces and carries a great deal of sediment into the sewers; where the streets are paved or macadamized, there is not so much sediment taken into the sewers but what the storm-water will carry off and thus prevent choking or clogging. In our smaller cities there are few paved streets, and there is too much loose material upon the street surface, to allow the storm-water to flow into the sewers. The storm-water flowing along the gutters would carry with it not only great quantities of sediment, but straw, leaves, paper, and other refuse which would clog the sewers quite often.

It is just as well that the sewers of a city do not receive the storm-water of its streets. Looking at it from a sanitary standpoint, it is better that the storm-water be allowed to flush the street surfaces: it is the only cleansing the streets receive. If there are parts of a city where the storm-water collects in a pool for lack of drainage, a drainage-pipe can be laid especially to carry off this water; there is no necessity of taking it into the sewerage system unless the pool is located quite a remote distance from a possible outfall.

A majority of the smaller cities in this country have adopted the separate system of sewerage. Its efficiency

as a system is unquestioned, while its economical construction and the rapidity with which it can be built commend it to every city. The smallest pipe laid in a street in the combined system is twelve inches in diameter; in the separate system the smallest pipe laid is eight inches in diameter. In the combined system the increase in pipe diameters is greater, proportionately to the distance laid, than it is with the separate system. The smallest pipe which should be laid in a street, as a sewer, is eight inches in diameter. The usual size of house-drains connecting with street sewers is six inches in diameter. When establishing a grade of a sewer on a street it is quite important that the street sewer be placed deep enough in the ground to drain all the cellars on the street. To accomplish this thoroughly, the grade—i.e., bottom—of the sewer should be from two and one half to three feet below the level of the cellars; the diameter of the main sewer, whether it be large or small, making a difference in this depth of a few inches, more or less. On residence streets, where the cellars are about one half their depth above ground, the sewers need not be laid as deep in the ground as they are on the business streets, where the first floors of buildings are but a slight elevation above the street level. Yet the grades of a sewerage system will arbitrarily govern the depth at which the sewers must be laid; and if the grades, which also govern the flow of sewage, are to be maintained, to secure a perfect gravity system, then the sewers must be placed at the depths required, whether it be six or sixteen

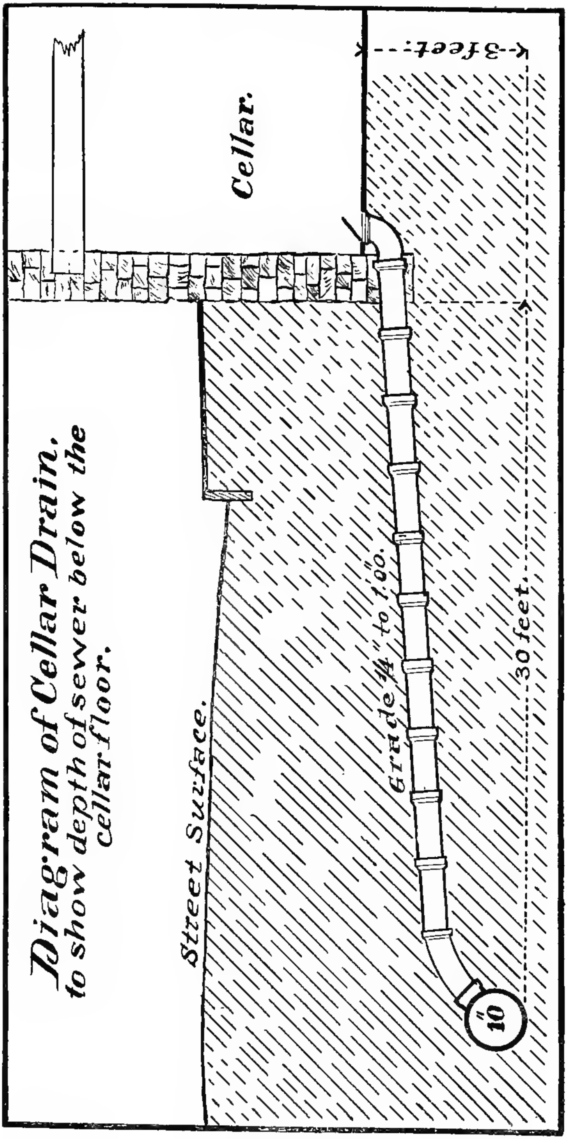


Diagram of Cellar Drain,
to show depth of sewer below the
cellar floor.
Cellar.
Street Surface.
Grade 1/4" to 1.00.
30 feet.
3 feet.
10"

feet below the surface of the street. The most expensive construction of a sewerage system is the main sewer and outfall, particularly so if the sewer is of brick and quite large in diameter, and the outfall is of stone and placed on an artificially-made foundation. It is for this reason that the length of the main sewer should be reduced as much as possible without danger of impairing the efficiency of the system.

When a community desires a system of sewerage planned, the disposal of the sewage is the first problem to solve, and in connection with this problem is the consideration of the topography of the area within the limits of the city, which should be carefully studied and mapped by an expert in such matters. There may be one place at which the public may desire the sewage to be emptied, yet the topographical conditions are such as to entail heavy construction expenses to concentrate the sewage discharge at that point. Sometimes the topographical survey will develop a better solution of the problem than was thought of, and less objectionable to the inhabitants than it was expected to find before the survey was made. The disposal of the sewage of a city, which means the location of the sewer outfall, is the most complex question the sanitary engineer has to encounter. Every locality gives him a new study, demands a different treatment, and calls for a wide range of experience.

The discharge of sewage into a lake, stream, or pond is often done under necessity, and it is to be deplored that it is ever done at all. The community needs the

sewers; and while it has the means to build as much of the system as will relieve its immediate needs, it has no money to provide a proper and unobjectionable method of sewage disposal. Therefore the system is built and the disposal of the sewage in an unobjectionable manner is deferred until some future time, when the accumulations at the outfall and vicinity become so intolerable that the community itself demand the abatement of the nuisance.

The location of a sewage outfall where it will discharge into living waters cannot be under any circumstances a permanent location; sooner or later all such sewage outfalls will be abated, and each and every city thus contributing to the pollution of our inland waters will be required to cleanse or otherwise purify its sewage and discharge only clean water into them. Some of the States have already prohibited such pollution, and several inland cities have been compelled to cleanse their sewage within their respective limits. As our cities grow larger and the population becomes more dense within them, the question of sewage pollution and sewage disposal will receive the attention it even now deserves, and the simplicity of its solution will perhaps cause us to wonder why it has not been solved much sooner.

The map of a sewerage system should show, when completed, the location of all sewers, with the different kinds (whether pipe or brick material) marked plainly thereon; also the grade of each line of sewer, as well as the size or diameter; it should also show the loca-

tion of the outfall or outfalls, man-holes (catch-basins, if the combined system is planned), lantern-holes, and flushing tanks. There should also accompany the map system a profile of the main and intercepting sewers, a detail drawing of outfalls, man-holes, flushing tanks, lantern-holes, respectively, with complete specifications for the performance of each and every kind of work required to be done to build the system, or any part of it, in a practical, workmanlike manner. The city or town having such plans made should also obtain, if it does not already possess it, a full and complete draft of a sewerage ordinance, from which an ordinance may be framed and adopted suitable to the requirements of the locality desiring it. The object of introducing such an ordinance is to regulate the construction and maintenance of public sewers, tapping and using the same; to provide for flushing, cleansing, and repairs; and to adopt a method of assessments whereby to raise money in an equitable manner for the payment of sewerage construction, etc. None but licensed drain-layers should be allowed to tap or make connection with the public sewers, and a record should be kept at the city hall of all such connections. The city should designate what kind and size of pipe should be used, not only for street sewers, but of all house connections laid between the street sewer and the block lines, and it should also require the use and employment of the best material and workmanship connected with the public sewers and house connections.

A sewerage system when built must be well built, otherwise it is a menace to public health; besides, if well built, the expense of repairs are reduced to a minimum.

The practice of connecting house-drains with public sewers while under construction should never be allowed. The earth in the trenches will settle and by its great weight break and detach the connections, causing much damage and expensive repairs. The newly-filled trenches should be allowed at least thirty days' time for subsidence; sixty days' time is even better. House-drains should have a grade of not less than $\frac{1}{4}$ inch to the foot. Flushing tanks that will contain about 200 gallons of water should be located at the upper end of all lines of sewers. There are several flush tanks on the market that are designed to work automatically, and give satisfaction to those using them.

When building sewers use the best material obtainable; the brick used should be well burnt, hard and smoothly formed, well laid with full mortar joint. The sewer-pipe used should be true in form and diameter and uninjured when laid; the joints well flushed and bedded in the best quality of hydraulic cement-mortar. The house connections should be of the same quality of material, and good workmanship should be the rule in all cases. Sometimes the economically inclined householder will buy culled sewer-pipe whereby to make connection with the street sewer, and expect the drain-layer to use this kind of pipe in his work. A

drain-layer who will knowingly lay such pipe should be fined heavily and also be deprived of his license.

In some cities the licensing of drain-layers and plumbers is vested solely in the chief executive of the city, permitting this officer to grant licenses and also conferring upon him authority to rescind a license whenever a holder thereof has wilfully violated the law while in the prosecution of his work. Summary examples of this kind are often beneficial to a community.

COST OF SEWERS AND APPURTENANCES.

THE cost of sewer construction varies much according to the local conditions. The freight on material is often the cause of a considerable increase of cost above the average price. The character of the earth in which the sewer is laid will sometimes almost double the cost of work. Rock, hard-pan, the prevalence of water in large quantities in the trenches, a loose sandy soil where continuous sheeting and bracing is required—all these difficulties which must be overcome are expensive factors in the cost of sewer construction.

Sewer-pipe should be paid for at a stated price per lineal foot for each size of pipe used or laid in the ground. Breakages, cracked and damaged pipe, are generally excluded from the contract and work, and are a matter of settlement between the contractor and dealer; hence it is better and more economical for a municipality to buy its sewer-pipe of the builder when it is laid in the ground than to buy it from a dealer and deliver the best of it to the sewer builder; otherwise the municipality must make the settlement with the dealer for breakages, etc. Where no troublesome and expensive obstacles are encountered the price for

building sewers of various sizes and kinds with appurtenances is as follows:

8-inch sewer-pipe, per lineal foot laid..	$0 50
10 " " " " " " "	0 60
12 " " " " " " "	0 70
15 " " " " " " "	1 00
18 " " " " " " "	1 20
20 " " " " " " "	1 30
24 " " " " " " "	1 60

Sections with slants or house connections are included in the foregoing prices. Catch-basins, man-holes, and flushing tanks are not included, but are extra, as follows:

Man-holes, complete, $25 to $35, according to depth.

Catch-basins, complete, $30 to $50, according to depth.

Flushing tanks (automatic) cost from $50 to $70.

Brick sewers cost about $1 per vertical foot, per lineal foot laid, measuring the extreme outside diameter of the sewer. Thus a brick sewer whose extreme outside diameter is four feet eight inches will cost $4.66 per lineal foot in place. If a concrete or timber foundation must be provided upon which to build the sewer, then this will be an additional cost.

In all cases the plans and specifications for the sewer construction should be prepared in the best manner, having a single aim to durable and permanent construction, then ask for proposals to build accordingly. If

the bids when opened are found to be too high for the amount of money provided for the work, it is an easier matter to curtail the amount of work after the bids are opened than it is to dicker with a contractor for better and more expensive work than was asked for by the plans and specifications, when they are found to be deficient in this respect.

THE VENTILATION OF SEWERS.

NO matter how thoroughly well a sewerage system has been built, there will be at times an accumulation of sewer-gas within the sewers. If the sewers are laid closely to true grades and are well flushed at short intervals of time, the accumulation of gases is largely reduced. There are many different methods suggested for ventilating sewers; none of them, however, are efficient, for the reason that the sewer-gas will not rise against the colder air above ground, but will follow warm currents of air within the sewers and branches and escape into such localities as the warm air may lead it. The temperature of most sewers is about 65 to 75 degrees (Fahrenheit), and will rarely ever be lower than 60 degrees. The tendency of movement of sewer-gas within a system is to the higher altitudes of the system and city in which it is built; therefore the householder on the hill is more liable to receive gas in his house, unless his pipes are well trapped, than is the householder in the valley.

It is always better to submerge the mouth of an outfall where it empties into a body of water; by doing so the mouth is sealed against adverse winds, which have a tendency to drive the gases through the sewer-pipe to the higher elevations of a system.

The man-holes of a sewerage system located on the

sewers at street intersections are supposed to furnish all the ventilation required for a sewerage system, but it is extremely doubtful if any sanitary engineer will claim this to to be an efficient method of ventilation. That they do allow some gas to escape is evident, but not all of it finds egress from the sewer by this means, as residents near man-holes will testify.

If man-hole covers along an entire street were all removed at the same time, and allowed to remain so for several hours, the escape of gas from that particular sewer would perhaps be greater during the time these covers are off than will ever escape through the small openings made in the covers for that purpose. It would be an unusual sight to see the sewer on a whole street ventilated in this manner. It is a common practice in many cities to trap the pipe connection of a catch-basin with the main sewer by turning the end of the pipe downwards into the catch-basin, so that the outlet is always below the level of water which remains in the bottom of it. The only reason for doing so, "that has been told," is that sewer-gas arising from the catch-basin would offend the noses of casual pedestrians were it not trapped. The casual pedestrian can run away from it if he chooses to do so; the householder cannot run away from it so easily. The sewer-gas which escapes into free air from man-hole and catch-basin leaves less to penetrate the house; therefore it is wiser and more humane to have less regard for peripatetic noses and more for the inmates of the household, by leaving the connection not trapped.

If sewers are carefully laid to grade, "straight and true as a gun-barrel," as is sometimes said of them, so that there is a constant movement of the sewage towards the outfall, there is less liability of offensive odors arising from them than if obstructions within hold the sewage in small pools. The movement of the sewage from the household sink or water-closet to the main outfall of the system should be constant and uninterrupted.

STREET-CAR LINES.

WHEN granting a franchise to a company to operate street-car lines in a town or city, care should be taken to define the gauge of the track to be laid. A gauge that is narrower than the wheel gauge of the ordinary wagon or carriage is a nuisance and should not be allowed in any city. Four feet eight and one half inches is the usual gauge of all wagons, and this should be the distance between rails of the street railway.

To determine the question of street occupancy and paving, the right of way allowed to a street-car company should be the extreme width of one car for a single track, and the extreme width of two cars standing side by side, on parallel tracks, where a double track is to be laid. This understanding of the right of way also defines the width of street which should be paved and repaired by the company. Thus the width to be paved at the expense of the company will be approximately a strip eighteen inches wide outside of the rails and the four-foot strip between the rails, where a double track is laid, besides the width between the rails of each track.

This amount of paving which should be done by the company is but a fair compensation to the property owners on the street whose frontage the company are

in part using as a means of gain or revenue, and it is no more than right that the company should relieve the property owners of a fair share in the cost of improving and maintaining the streets in a good serviceable condition. Besides, the street cars really occupy more of the street than is defined by the laying of one or more tracks, whether the franchise says so or not. Vehicles are required by city ordinance, as defined by the franchise, to abandon the tracks on the approach of a street car, that it may proceed on its way without detention, and the signal used by the car-driver to warn vehicles when on the track is sanctioned by the ordinance or franchise; and if the driver of the vehicle does not heed the signals, he can be fined for not doing so. The driver of the vehicle must move far enough from the track, either one side or the other, to allow the body of the car to pass, thus giving up to the street car a width of at least eight feet of street.

The street-car company should be required to lay and maintain its tracks to the established grade of the streets; and when a street is paved or otherwise improved, the share of the work to be done by the company should be performed at the same time the city's work is done.

In some cities the number of street cars used and owned by the company are registered at the city clerk's office and are licensed to operate by the city, the company paying a stipulated sum for each license. These sums vary with different cities: $10 in some cities; $20 and $25 annually in others. In Baltimore,

Maryland, the city required the street-car companies to pay one cent from each fare collected to the city. The companies therefore charged a six-cent fare and thus became tax-collectors for the city without any expense to themselves. Had the city restricted the fares to five cents per capita per ride, the result to the street-car companies would have been widely different.

This is an instance where cities are overreached by exacting terms that are not fully considered, nor all the results carefully weighed when the franchise is granted. When a city grants a franchise to a street-car company it should state the exact terms of the franchise so that they cannot be evaded, or leave them out of the franchise altogether. To exact the condition that "car fares shall be but five cents per capita on a certain line" does not insure a five-cent fare to the patrons of that line unless the distance is also stipulated which a patron may ride for five cents; because the street-car company can make two distinct sections of its one line, as has been done.

In some franchises restrictions have been incorporated which prevent the company from charging additional fare upon a line or lines running to fair or exposition grounds and to certain parks or places on legal holidays, also requiring the street cars to be at the depot to meet incoming trains; but such restrictions are not usually necessary. The street-car companies in most cities endeavor to take care of all public travel which comes their way in a liberal, commendable manner. The most serious complaint against street-car

companies is the overcrowding of the cars, especially in the morning and at night when the people are going to and from their daily work. But the people themselves are largely to blame for this evil; they will mount an overcrowded car until every foot of space inside and outside is occupied, pay their fare to the conductor, and then do their grumbling. If they would do their grumbling before they paid their fare, some good might come from it.

Street-car companies operating horse-car lines should be allowed to lay cobblestone pavements between the rails of a track on steep grades. Such a pavement is a merciful provision for the animals hauling the cars. The residents on a street generally object to cobble pavement because of the noise; but the service the company owes to the public demands it and it should be permitted. A wood pavement on a steep grade is wet and slippery and very severe on the animals hauling the car, and when cars are heavily laden much time is consumed climbing such hills or grades.

A street railway built with rails laid on longitudinal stringers is not as serviceable a track nor is it as pleasant to ride upon as a track laid on cross ties, with stringers supporting the rails. The cars, after a few weeks of travel over it, take to bobbing up and down like a storm-tossed vessel, which is very disagreeable to the occupants. The track laid on cross ties is, if well ballasted and well kept, as pleasant and smooth riding as any steam-railway track.

With the introduction of electric motor street rail-

ways, heavier cars have come into use and the rails used are heavier. The girder rail laid by the Cream City Railway Company of Milwaukee weighs 89 pounds per yard. The old horse-car lines used rails varying in weight from 45 to 60 pounds per yard. An economically wearing rail, one that will not kink under heavy loads, should be not less than 60 pounds per yard.

STREET SPRINKLING.

EXPERIENCE has proved that the most satisfactory method of sprinkling streets is to place the work entirely in the hands of the municipal authorities. When two thirds of the property owners on a street petition the council to have it sprinkled there can be no legal obstacle that will prevent a proper assessment of the abutting property on that street to provide the necessary means to pay for the sprinkling. When such work is done by the property owners it is seldom well or satisfactorily done. Some owners will not subscribe for the work, and their frontage is therefore not sprinkled; the gaps thus left are a positive nuisance to those who do pay for the sprinkling, because they do not receive the protection from dust which they pay for. The whole block or street should be sprinkled, if sprinkled at all. If a street-car line traverses a street, the car company should pay for one third the sprinkling.

In some cities the cost of sprinkling is paid entirely by the city from a general fund; in others the cost is paid by assessments made against the abutting property, the city itself bearing no share of it whatever. Sometimes a city will assess the abutting property from two to three cents per lineal foot of frontage and pay

the balance from a general fund. There is much difference in the cost of street sprinkling as paid by different cities and towns; it is not readily understood why one city should pay twice as much per mile for street sprinkling as another, when both have a water-works system and the scarcity of water does not enter into the conditions in either case; nor is it apparent even why one city should pay $200 per mile more than another, yet statistics on street sprinkling show such differences.

It is claimed that an assessment of five cents per lineal foot of frontage, or ten cents per lineal foot of street, will pay for the cost of sprinkling the widest street. This rate of assessment equals $528 per mile of street and is from $100 to $250 less per mile than is paid by our largest cities.

At St. Louis, Missouri, the cost for eight months' sprinkling per mile of street is about $700. The city furnishes the water free of cost to the parties doing the sprinkling. At Rochester, New York, the cost is about $781 per mile of street.

At Racine, Wisconsin, the water company charge the party doing the sprinkling at the rate of one and one fourth cents per lineal foot of street sprinkled; to this must be added cost of sprinkling. Some cities pay $100 per month, for a season or six or seven months, per mile of street, and the water furnished free by the city. Water companies supplying cities with water have stated rates for street sprinkling incorporated into the franchise when granted; these rates vary from three to five cents per lineal foot of frontage, and some have

a rate as high as five cents per square foot of street area. These prices are for the water alone; the labor of sprinkling is additional.

Contracts for sprinkling require the streets to be sprinkled three times daily, excepting Sundays, on which day the streets are to be sprinkled once and before 9 o'clock A.M. In some cities no street sprinkling on Sundays is required.

The carts are generally required to cover not less than two miles per day, each, on a street having an average width of thirty-six feet between curbs. On level streets, or rather streets that have comparatively light grades, carts can do much better than this. The spread of the sprinkler is eighteen feet, and a cart contains not less than 600 gallons of water. All water-carts should have wheel-tires not less than three inches wide, for they have heavy loads.

It has been estimated that a cart can cover from five to six miles per day (single spread) of ten hours. The distance which can be covered by a water-cart in one day depends somewhat upon the facility for supplying it with water.

A city owning its water-works can make cheaper contracts for sprinkling than if it purchases the water from a company, but it does not follow that the cost of supplying the water is less for a city than for a water company. Few cities operate a plant as cheaply as the water companies do; the reasons therefor are obvious.

THE STREET SURFACE—PAVEMENTS AND IMPLEMENTS.

WHEN it is contemplated to have a street paved and the improvement is to be paid for by assessments made against the abutting property, as is the usual custom, a map drawn to some large and convenient scale should be made, showing and including all the property which may be affected by the improvement. If a street-car line traverses the street, the area which the street-car company must pave, or pay for paving, should be laid off on the map, then the frontage of each piece of property located upon each side of the street should be defined. The street-car area can be washed in one color, all the property owned by individuals in another color, and the city's share of the work defined with a third different color. Then compute areas by square yards and note the number of yards and fractions thereof upon each individual tract, respectively.

A map thus prepared is not only a satisfactory exhibit to the property owners who are pecuniarily interested in the work, but it otherwise serves many purposes and interests; the council, the assessors, the engineer in charge, and the contractor who performs the work, all have a correct and reliable guide which

will enable them to carry on the entire improvement and make compensation therefor in an intelligent and satisfactory manner.

To go into the details of street paving would be intruding upon specifications for such work, and there are different specifications for different pavements and localities. The intention of this work is to describe the essential features of municipal improvements, omitting those details which would not only be inapplicable here, but would make the work cumbersome.

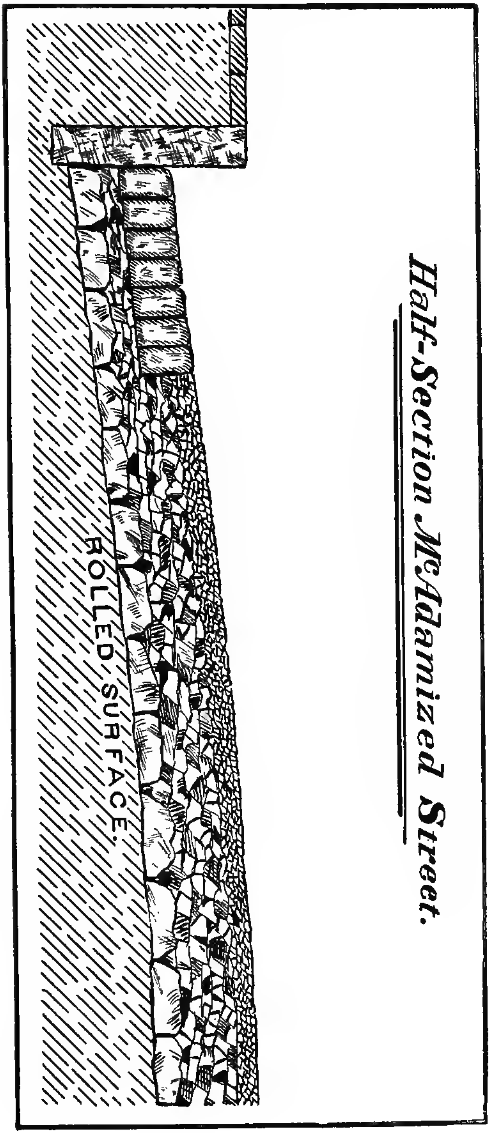
Every community must decide for itself what sort of paving material it will adopt for its streets. Often the local quarries will settle the question, or the stone they can buy at a distance and transport at low or reasonably low freight rates. In Illinois, stone and brick are chiefly used for pavements. In Wisconsin cedar and tamarack blocks, granite and limestones are used. No paving brick are made in Northwest north of the northern line of Illinois. Few of the limestones make good pavements, because of their brittleness. Granite fashioned into the shape of the "Belgian block" is used on the main thoroughfares of most large cities and makes a good wearing, durable pavement, but is almost as noisy as the old cobblestone pavement. Not all stones that are hard make good paving material, nor should many of the softer stones be rejected because they are not hard. Many of the gritty, softer stones will wear evenly and smoothly and are not as prolific of noise as the harder and more brittle stones are.

The asphaltum pavement is the ideal pavement, and its adoption is increasing largely every year. The average property owner does not favor it, because of its expensiveness.

Wood pavements in their best condition are simply makeshifts. They are not durable, do not wear smoothly, are not cleanly, and in a few years they become so rotten that they are a menace to the health of the inhabitants residing on the street where such pavement is laid. A wood pavement that is well sprinkled during the summer months is as prolific of mosquitoes as are the cedar woods in the wilds of northern Wisconsin.

Brick pavements seem to have many advocates in their favor in our smaller cities and a much less number in our larger cities. Excepting in some few localities it is comparatively a new paving material and is notably increasing in favor every year. It is not as "noisy" as a stone pavement, it is less dusty than is a macadamized roadway, and it is not so utterly disagreeable in so many ways as is a wood pavement. The most serious objection raised against the brick pavement is the difficulty in securing a uniform hardness of brick. Whether or not this objection can be remedied remains to be seen. The price per square yard, laid, for brick pavement seems to hold a half-way place between the cost of stone and wood pavements.

For residence streets in a city and suburban highways the Telford-McAdam pavement, laid as this pavement should be laid, is a very desirable and a popular



Half-Section McAdamized Street.

road covering or pavement. But broken stone has been so long used in many communities solely to fill a bad mud-hole or quagmire in a highway that its efficiency and value as a good road covering are undeservedly in low repute.

The road roller is a necessary implement for good work either on pavements or highways. The roller should be made to weigh about three tons, with facilities for increasing the weight to five or six tons, by loading it with some heavy material.

A good serviceable rock-crusher is also a desirable implement for a municipality to own for the work of road or street making. A crusher that will crush about 40 cubic yards of stone per day, with a carrier attachment for taking the stone from the crusher to the wagons, costs complete about $1000. A portable engine to run the crusher can be purchased or rented. The cost per cubic yard for crushing stone is quoted at from 25 to 50 cents. The writer crushed during one season nearly 7000 cubic yards of black gneiss at a cost of 19 cents per cubic yard delivered to the wagons. This price included a small royalty paid to the owner of the quarry for the stone used. It is far cheaper to set up the crusher in the quarry than it is to haul the stone to the crusher, as is sometimes done. A valuable auxiliary of the stone-crusher is the revolving screen which separates the stone into three different sizes. The screen is about 10 feet long and 3 feet diameter and is made to revolve about twenty times per minute. The screen is divided lengthwise into

three sizes of mesh: the smallest is ½ inch, the next large is 1½ inches, and the largest is 3 inches. Undoubtedly the day is soon coming when every enterprising, well-administered city and town of the smaller class will be equipped with the road-roller, the stone-crusher, and revolving screen, and carriage travel within and about these municipalities will be a pleasure and not a dread to the inhabitants thereof.

Regarding the cost of pavements per square yard, it varies with the locality where the work is done. Unless the town or city is located in a region where cedar grows, or good paving stone can be quarried, or paving brick is made, the cost of transportation will alone make a marked difference in the price. Limestone pavements have been laid in the Northwest for $1.40, $1.60, and $2 per square yard; granite pavements for $2.45 and $2.80 per square yard; cedar block pavement at 90 cents to $1.25 per square yard; McAdamizing from 70 cents to $1.20 per square yard. Stone curb, 4 inches thickness, 50 to 70 cents per lineal foot, set in place. When pavements are laid on a concrete base this cost is additional.

The price for brick pavement, double thickness of brick laid, varies from $1.50 to $2.40 per square yard.

There is no pavement better than a first-class asphaltum pavement; it combines all the essentials of a good pavement and, with the exception of being quite slippery for horses, it has none of the objections which other pavements possess. The price per square yard laid is from $3 to $3.50.

We are told that lumber is getting more scarce every year and consequently dearer in price. It will be better for all municipalities when lumber becomes too expensive to use for sidewalk and pavement material. It is uncleanly and unhealthful, and the sooner it is banished from streets and sidewalks the better. According to vital statistics, the third in rank of healthful cities of the world is Baltimore, Maryland, and this city has neither wood pavements nor sidewalks.

GAS CONSUMPTION.

IT is authoritatively stated that the street lamps in cities consume about four cubic feet of gas per hour, and an ordinary single-jet house burner will consume from 6 to 8 cubic feet of gas per hour. Haswell says: "Internal lights require four cubic feet and external lights require five cubic feet per hour." Gas-tips are sold by dealers which are alleged to burn a specified number of cubic feet per hour and are rated as "three-foot burners" or "four-foot burners." This is an empirical rating which rarely ever will withstand an actual test. The consumption of gas per hour which these burners will consume is generally a great deal more than the rating signifies. The actual quantity of gas a tip will consume per hour, regardless of its rating, can only be determined by a test made with the tip itself; and the test will not always be a true rating for another tip of the same size and manufacture.

The amount of gas which any tip or burner will consume in one hour also depends upon the pressure and the specific gravity of the gas furnished. The following testimony by an expert on this subject is quite important.

The superintendent of the lighting of streets and public buildings by gas in the city of New York says

that it is not essential nor customary that the tips used in burners within the different street lamps should be of any particular kind, mark, or of any uniform size; that the quantity of gas to be furnished for street lamps is not determined by the size or kind of tips used in the burners, or by the number of the marks or rings thereon, but by the actual number of feet of gas per hour passing through the burners in the lamps at the place where the same is located. That the amount of gas consumed by any burner depends not only on the kind and size used thereon, but also on the pressure at the particular place where the street lamp is stationed, and also on the kind and specific gravity of the gas furnished.

STREET LIGHTING.

UNQUESTIONABLY the best modern illuminant for streets is the electric arc light, each lamp being not less than 2000-candle power. Many object to it solely on account of its brilliancy, yet that is its chief value as a street light. When the arc light is enclosed in an opaque glass globe its extreme brightness is so modified that the glare is less blinding to the eye. Sometimes these lights are hung extremely high, anywhere from 60 to 100 feet elevation above the street. To obtain the best illuminating effect they should never be hung more than twenty-five feet above the ground; then the reflection from the buildings on the street gives additional light. When the lamps are hung very high, higher than the buildings, their light falls upon the roofs, and the street surface receives all the shadows. Where the foliage of shade trees is very heavy and spreading, as it often is on residence streets, it will be found that the lights will give better results if hung at an elevation of about eighteen or twenty feet than if hung higher.

The incandescent system is not suitable for street lighting; it is not powerful enough, and not much bet-

ter than the gas lamp, especially where the foliage of trees is heavy and spreading. To give as good an illuminating effect as the gas lamp will upon the street surface it must be hung quite low—lower than is required for the arc system.

To know that a company is furnishing electric lights of the required candle power, the city should employ an expert to make tests from time to time, and the company notified of delinquencies in this respect. Where such tests are not made there is a tendency towards diminution of the strength of the lights which is sometimes quite apparent.

The annual cost of electric lighting varies with the conditions required. Where the lights are required to burn from sunset to daybreak they cost each (arc system) from $100 to $125 per year, according to the number installed. Where they burn from sunset to midnight they cost each from $70 to $80 per year, depending upon the number installed. A plant having 200 lights can afford a lower rate than one having only 80 or 100 lights installed.

The incandescent is cheaper than the arc light, but more lamps are required for the same street area.

Yearly Table for Street Lighting; showing the Number of Hours from Sunset to 12 o'clock Midnight, for each Month in the Year.

Month.	Total per Month.	Average per Night.
June	136 hrs. 55 min.	4 hrs. 34 min.
July	145 " 52 "	4 " 42 "
May	150 " 38 "	4 " 51 "
August	161 " 16 "	5 " 12 "
April	162 " 47 "	5 " 25 "
September	175 " 24 "	5 " 51 "
March	189 " 06 "	6 " 06 "
February	188 " 59 "	6 " 45 "
October	202 " 41 "	6 " 32 "
November	210 " 35 "	7 " 11 "
January	225 " 16 "	7 " 29 "
December	230 " 25 "	7 " 38 "

This table may be used for either gas or electric lighting.

STREET GRADES.

PERHAPS there is no other municipal improvement that will raise a longer and louder blast of indignation from property owners than the grading of a street. When such a job is under way the alderman who began it most generally wishes before the work is finished that either himself or that particular street had never existed; while the vocabulary of names having reference to imbeciles and other persons with little or no minds is exhausted, and poured upon the head of the city engineer. To the average property owner a street consists of an area of land embracing the frontage of his own property. He does not care particularly for any other portion of the street, as long as he is permitted to make good drainage on his own front and allow the water to pass on for some other property owner, located on lower ground, to care for.

The principal cause of the trouble which arises from grading a street in most towns and cities is that the blocks have been built upon and sidewalks laid about them ever since the settlement of the country, without street grades and drainage having been previously provided or established. Perhaps a few grades have been established in the business part of the city, but

the larger area has been built up without them, every property owner erecting his building according to his own inclinations. Trees have been planted and have thrived handsomely, located not only on the curb line, but outside as well as inside of it. For years the streets have been under the care of successive street commissioners who have scraped, ditched, guttered, and graded them to suit the notions of many property owners. When the time comes for the improvement of the streets, to secure good drainage so that there will be no excessive concentration of storm-water at any particular place; when water-works, sewerage, paving and macadam are introduced; when street grades are established and profiles of surfaces and grades are made and placed on file in the city hall—it is about this time that the air becomes turbulent with muttered imprecations and threatened suits at law against the city for damage to property, and at the next municipal election a strong cabal is formed to defeat the re-election of the offending alderman, and a successor to the city engineer is sought for—one who will ignore the established grades and respect the old-time condition of things.

A street is graded for several reasons. One reason is to make good drainage and take care of the flowing water without its damaging any private property. The grading of a street in most instances means a more rapid concentration of storm-water as a result. In many cases streets are graded not only to place them in a better condition for travel during wet sea-

sons, but to reduce grades and thereby facilitate traffic upon them. And there is an æsthetic reason which is appreciated by every one, for we all admire a handsome street. When a street is graded and all the considerations are judiciously carried out, the property located thereon is not damaged, on the contrary it is very much improved and the assessments for the work are in the nature of benefits, as they should be.

Where buildings have been erected years before the street grades were established and the later grading of the street puts them above or below grade, there is no alternative for the owners but to conform to the new order of things; and if they deem this a hardship and an expensive matter, there is visible evidence existing for a jury to see and decide how much compensation they are entitled to because of the change of street surface.

The stranger visiting a city for the first time does not always remember the handsome buildings it may have; but if its streets are execrable he never forgets them, and if the streets are handsomely improved he will ever after speak of that city in a praiseworthy manner.

The sidewalks on a business street should be fifteen feet wide; if the street is sixty feet wide this will leave a roadway for vehicles thirty feet wide. When the business streets are but sixty feet wide two street-car tracks should not be allowed upon them if there is nothing to prevent a return track being laid upon another parallel street. If two tracks upon one street

are a necessity, then the width of sidewalks should be reduced to twelve feet.

On residence streets the sidewalks can be held to the width of fifteen feet without detriment to roadway travel. The footway proper can be made seven feet wide, leaving eight feet width for a grass-plat and the curb; this width and arrangement is not only an ornament to the street, but reduces the paved area of the roadway.

The cities of our Northern States require deeper gutters than those of the Middle and Southern States, because the snow and ice in winter compact upon the street surfaces to a depth of six or more inches, and when a thaw comes the flowing slush will flood the sidewalks if the curbstones are set too low. In this case the surface elevation of the curb should be six inches above the crown of the street, and when paved the grade of the gutter should be eight inches below the crown of the street; this gives a depth of gutter at the curbstone of fourteen inches. Ordinarily the surface elevation is the same as the centre of the street.

For a macadam roadway thirty-four feet wide the crown of the street should be fifteen inches higher than the gutter.

On comparatively level streets the intersections should be made level. Where the grades are quite steep, crossing streets which are level (or nearly so), the down-hill side of the intersection should be made from eight to twelve inches lower than the up-hill side; otherwise there will be a bad pitch on the cross

street from the lower crossing. Change or break the grades of streets at the intersections where possible to do so. Where this is done the streets present a much better appearance than if grades are changed midway between streets. Require all property owners on a street to make water and sewer connections before the work of paving begins, and thus save the pavement from future destruction; otherwise it will be cut up continually to make these connections, and none will regret such work more than the property owners on the street.

A WATER-WORKS SYSTEM.

THE advantages of a well-built and efficient system of water-works to any community are obvious; its chief requisite being a plentiful supply of good, wholesome water at all times and for all reasonable purposes.

The water supplied should be, if obtainable, free from objectionable and mineral matter; not too hard, that is, not impregnated with lime or its constituents to that degree which renders it unfit for steam, laundry, and many manufacturing purposes. If a water supply is thus rendered unfit for all general uses, its sale to consumers is just that much limited and the income from the sale of water is thereby curtailed. Oftentimes a citizen of a town or city will say, when the question of building a system of water-works is discussed, "Oh, we only want a small system to supply us with water for cooking and drinking." That citizen has to learn that the sale of water for such purposes only will not pay the cost of operating a plant, and the deficiency of income to meet operating expenses must come from a general tax levy. The works should be built upon the broad plan of supplying water in quantity and quality desirable and suitable for all general purposes—a truly commercial water—with the intention of selling every gallon possible. Of course

not all sections of the country are favored with water of this kind and excellence, and the best water obtainable in one section would be rejected with disdain by a community of a more favored section.

There are some sections of the country where the artesian wells supply an abundance of the best quality of water good for all purposes, and there are other sections where artesian wells are not only a very unreliable source of supply, but the water from them is very objectionable for any use but the extinguishment of fires—provided that enough of it can be had when wanted for this purpose. As a rule the artesian well as a source of supply is out of the question when considering a sufficient supply for a town or. city of any considerable size or population.

An artesian well that will discharge 100 gallons per minute is a rarity; many of them discharge only 18 to 30 gallons per minute. A discharge of 100 gallons per minute is but 144,000 gallons per day, and this quantity is a meagre supply for an ordinary, sized village. This quantity of water does not afford even fire protection, for there is but 6000 gallons per hour available, and two fairly good fire-streams require, each, 160 gallons of water per minute, which in the aggregate amounts to a discharge equal to 9600 gallons per hour. The artesian well fulfils its mission in those localities where there is no other supply obtainable.

The source of supply should be located, where possible to do so, where there will be no danger of future contamination, and to make such assurance *sure* the

location and outfall of the main sewerage of a town or city should be considered at the same time that the water-works system is planned. Lay no pipe in the streets less than six inches internal diameter. Only one efficient fire stream can be had from a four-inch water-pipe, and only single-nozzled hydrants can be placed on such a diminutive pipe-line. A cast-iron six-inch diameter pipe, well laid in the ground ready for use, costs 40 per cent less per lineal foot, so laid, than does good rubber hose per lineal foot; one double-nozzled hydrant set in place ready for use costs about $30—showing that cast-iron pipe and hydrants are a cheaper fire protection than is the best rubber hose. Yet the rubber hose must be kept on hand whether or not a city has a water-works system, but not so many lineal feet are required to be kept on hand. The fire department of a city without water-works is compelled to use long lengths of hose to each pipe-nozzle because of the remoteness of the water supply, using lengths varying from 800 to 1200 feet, while a city having water-works, and hydrants located at alternate blocks, seldom uses more than 300 feet of hose to a pipe-nozzle and more often only 100 or 150 feet of hose, thus supplying from four to eight streams from the same length of hose which in the first instance supplied but one stream, and a weak stream at that; for the pressure loss when rapidly conveying water through 1000 feet of hose is very considerable, and the pressure is so great that there is usually a heavy loss in bursted hose at every fire where long lengths are used. A

certain city having a population of about 7000 keeps for use about 30 per cent more hose than a neighboring one does having a population of 20,000 and equipped with a water-works system.

A good cast-iron water-pipe thoroughly coated with iron varnish and well laid in the ground, has a durability that is practically unknown to-day, while the durability of the best quality of rubber hose is scarcely more than four years. A well varnished cast-iron pipe does not decompose in the ground unless there are deleterious gases or chemicals in the soil about it.

The water-pipe throughout a system should be amply large to ensure sufficient fire pressures at all the hydrants of the system. In cities with a population of 30,000 or less the system should be so planned that no steam fire-engines need be used for the extinguishment of fires. The pressure at the hydrant should be such that with the aid of the hose efficient fire-streams can be thrown upon a burning structure with satisfactory results and without the aid of a fire-engine. There are several cities in the Northwest where fire-streams are thus used and the fire-engines, purchased before the water-works were built, have never been taken from the engine-house to serve at a fire, although five or more years have elapsed since the water-works were built; in the meantime quite large fires have occurred in these cities, which were combated successfully by the firemen with hose attached to the hydrants.

A city having a population of about 5000 pays usually an annual hydrant rental of about $4000. To

maintain a fire department equipped with steam fire-engines would be an additional expense of $2500 or $3000 unless the water-works system was properly planned so as to afford ample hydrant pressures, when two-horse hose-carts would be the most expensive equipment needed.

Where a city depends upon its fire-engines and not its hydrants for streams, the number of streams available at a fire is the number which the steam fire-engines can throw. With adequate pressures at all hydrants, the limit to the number of streams which can be thrown will be the number of hydrants available in the locality of the fire; and if some of the hydrants used are located upon the larger pipe of the system, then the double-nozzle hydrants will also furnish a much greater number. Where a planing-mill or other wood factory takes fire and a high wind prevails at the time, many streams are required to prevent the fire spreading to localities outside of the course or route taken by the conflagration: these incipient fires are caused from flying brands carried among the buildings by the prevailing wind, and unless extinguished at once the devastation is widespread, and the fire loss will be immensely greater. Instances of this kind have occurred in this country where from thirty to forty streams were necessary to prevent a conflagration from becoming widespread. It is a very large city that is equipped with twelve steam fire-engines, and none of our cities, having a greater or less number of fire-engines, depend upon hydrant pressures for fire-streams. The real

reason why cities as a rule do not provide adequate fire pressures at hydrants, and maintain instead large and expensive fire-department machinery, is the false economy of laying small pipe. Outside of the fire department and the engineering staff of a city, the value of pipe, pumps, and water of generous measure and capacity is not generally appreciated, nor are they extensively provided.* The experienced fireman will say, if asked to name the conditions which make an efficient fire-stream: a stream of water forced through 200 or 250 feet of two and one-half inch rubber hose, with a smooth nozzle not less than one and one-eighth inches diameter and a pressure at the hydrant of not less than sixty pounds, such pressure and streams throw 185 gallons of water per minute, to an elevation of 74 feet. Yet this fireman is giving almost minimum conditions; he would undoubtedly prefer a smooth nozzle one and one-fourth inches diameter and eighty pounds pressure at the hydrant, which would discharge 239

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* At the great fire in Milwaukee, Wis., October 28, 1892, there were available in the city eighteen steam fire-engines and a steam fire-tug on the river with a capacity of eighteen streams more, although not all available at one time. The city made a call upon neighboring cities for help, and fire-engines came from Chicago and intervening cities to the number of eight. A very high wind prevailed at the time of the fire, and the area burnt over had been previously covered with old-time, cheaply built, wooden houses, with some few factories and buildings of the better class among them. The hydrant pressures alone were not sufficient to furnish fire-streams. The sole dependence of Milwaukee was her eighteen fire engines and the steam fire-tug.

gallons per minute to an elevation of 80 feet. These streams would be, at the heights specified, solid columns of water, not sprays of water which spread in mid-air and feed the flames. The average pressure maintained by steam fire-engines at work is, for steam, 100 pounds per square inch and from 130 to 160 pounds water pressure. Oftentimes even greater pressures are used.*

If all cities of the larger growth could be divided into prescribed areas, with lines of large pipe well stocked with hydrants to a reasonable number, such pipe lines would afford a more practical and safer barrier against the sweeping conflagrations which oftentimes devastate large districts than anything that has yet been done in our American cities to check such fires. The best conditions of water-works construction, combined with the best principles of fire-resisting construction, must be observed and practised in our larger cities if we would save them from the great destructive fires which are nowadays a quite common occurrence. In our large cities, where the population is more dense, where the daily domestic and factory consumption of water is great and the busi-

* While advocating the use of large pipe and heavy pressures, the writer does not mean to convey the idea that our larger cities can dispense with the steam fire-engine; the prevalence of tall buildings and the modern sky-scraper building not only demands their retention, but also requires engines of larger capacity than those now built and used.

ness blocks are very tall, the standpipe loses its utility as a reservoir, and its static pressure is of little avail; in such instances the supply and pressure for all purposes must come from the pump direct, and steam fire-engines must be employed to take the water from the hydrant and throw it upon the burning structure. For cities of the second and third class the standpipe is a great economical factor in the operation of a system, and a valuable adjunct to its utility. It saves the cost of steady pumping day and night, including the labor of a night engineer and fireman and the fuel they would burn during their hours of duty. The stand-pipe affords a steady static pressure at all times, and provides a large supply of stored water, which by its altitude is available at once for the extinguishment of fires. To say that this use of water is not possible or practicable because the engineer might neglect to keep the standpipe filled is tantamount to saying that railway trains cannot be run on time because the engineer might fail to keep up steam: a pressure gauge or an Edison recording gauge, posted in the office of the mayor, or of the chief of the city fire department, will tell at a glance whether or not the tank is full and the engineer attending to his duties. The great utility and economy of the standpipe is recognized wherever it is used.

The largest standpipes built in this country are 20 and 25 feet diameter, with tank 100 feet and more in height. The extreme height is in many instances increased by placing the tank on a brick or masonry

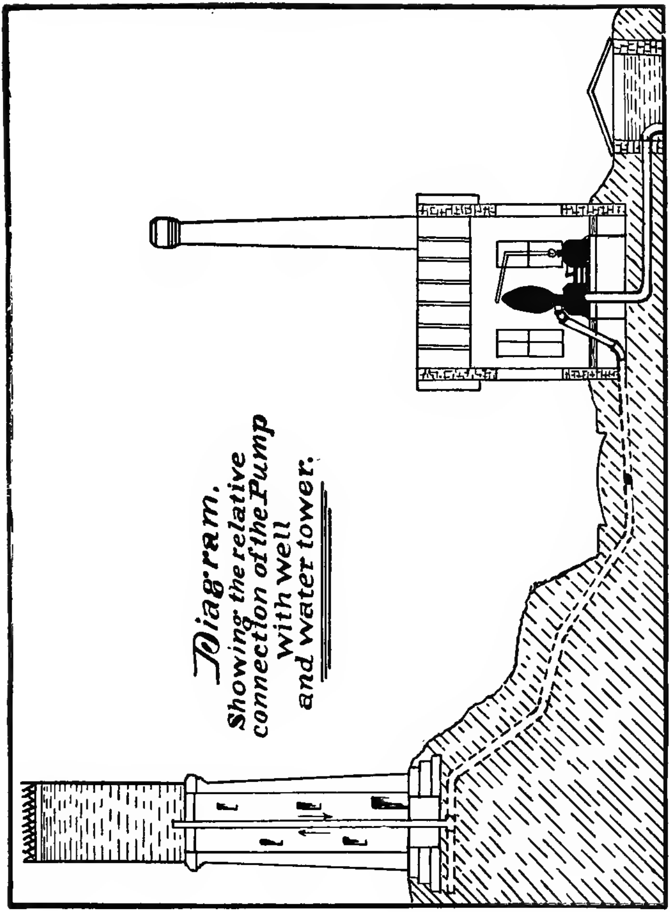


Diagram.
Showing the relative connection of the Pump with well and water tower.

tower varying from 50 to 100 feet high; the static pressure desired determines the total height. Where a high elevation of land exists near a city the total height of standpipe can be materially lessened by placing it upon such elevation. Where a standpipe is incorporated in a system of water-works, the engineer's duty is to keep it full; his pressure gauge placed in the pump-room will show him at all times what the elevation of water is in the tank. In most instances the tank is kept full by pumping only morning and evening and during a conflagration; where there is a great constant demand for water during the day, as is the case in a manufacturing city, the engineer must pump at noon as well as morning and night. The intervals at which the pumps remain idle depend upon the capacity of the standpipe and the hourly consumption of water. The standpipe was first designed to afford relief to the pumps and protection to the pipe system from injury by "water-hammer," but of late years it has been increased in size and become utilized as a storage reservoir; thus in the modern water-works system it serves a twofold purpose.

The earlier settlers of the West voted money quite lavishly to secure railway facilities, and they handed down to the present generation in many localities some heavy bonded debts. The effect of these debts upon the present generation is that they have a very great dread—it may be said, an unreasonable dread—of any and all public improvements which cannot be built without an issue of bonds whereby to provide the nec-

essary funds. Consequently there are numerous towns and cities in the West to-day without water-works, sewerage, improved or paved streets. Yet the denizens of such towns and cities have lived on the same spot, the same ground, using water from the same old well, and casting all manner of filth upon the same ground as they have continued to do for the past forty and in some instances sixty years, yet will persistently vote down any proposition which will secure them a water-works or a sewerage system upon very favorable terms. In nearly every instance it is noticeable how rapidly a small city thrives and grows in wealth and population when it has in operation a water-works and sewerage system. In a few years the increased wealth contributes a tax levy to the municipal treasury greater than the annual outlay which the improvements cost the taxpayers. A good water-works system costs the consumer (the taxpayer) but very little; if he pays a water rate of $6 per year for one faucet in the kitchen, he gets all the good water the household needs for the sum of one and two-thirds cents per diem. This sum is less than it costs to maintain a pump, and the faucet supply is vastly more convenient to the household than a pump ever could be.

Items from the Report of the Superintendent of Water-works, Madison, Wis., for the Year 1891–2.

Population, 13,246.

Total number of water takers, 1405.

Greatest number of gallons pumped per day, 925,000.

Smallest number of gallons pumped per day, 375,000.

Number of gallons pumped per pound of coal, 189½.

Number gallons of pumped for one cent of fuel, 924.

Average head pumped in feet, 214.

Total number of tons of coal consumed during the year, 522.

Cost of coal during the year, $2140.20.

Receipts for the year were $15,372.26.

Operating expenses were $7564.25.

The system is direct pressure.

Cost of Operating a Water-works System and Collecting its Revenues. Taxes not included.

For a city with a population of 10,000, standpipe system:

Superintendent	$1,000 00
Engineer	600 00
Fireman (and other duties)	360 00
Fuel, oil, waste, etc.	1,000 00
Repairs, etc	300 00
Annual cost	$3,260 00

For a city with 2000 population, standpipe system:

Supterintendent and engineer	$700 00
Fireman and helper	300 00
Fuel, oil, and waste	500 00
Annual cost	$1,500 00

City clerk collects the revenues.

In most instances the cost of maintaining a horse and wagon should be included in the annual expenses. It is difficult to obtain exact figures of cost of operating a plant. The water companies decline to furnish such data. Water-works accounts of the smaller cities are not as a rule kept in a classified form available for such showing.

The foregoing statements are taken from cities where the standpipe is used; where no standpipe is used and the daily pressure is furnished directly from the pumps, the cost of operating expenses is increased very largely. In the smaller cities the employees in the water department have sometimes other duties to perform outside of the water department, and instead of the superintendent of the works caring for its revenues, the city clerk is appointed to do so. It is because of these complicated duties of water-work employees in the smaller cities that exact items of the cost of operating the works cannot be readily obtained.

Where water is supplied to a city under a franchise by a private company, the city pays an annual rental at such price as may be agreed upon between the city and the water company when the franchise is granted. This sum varies considerably. The water companies that supply by direct pressure (without a standpipe) usually charge more hydrant rental than those that build the combined system (that is, furnishing both pump and standpipe pressures, as may be called for from time to time). The usual price per hydrant is

from $45 to $50 annually, and $30 to $35 annually for all additional hydrants located on future extensions of the pipe system. One city in the West is paying an annual hydrant rental of $70, another $68, and a third pays $60. All three cities are supplied with water by direct or continuous pumping. These rates are considerably higher than are paid by cities having a combined system, both pump and standpipe.

A standpipe 16 feet in diameter, 50 feet high, containing 75,375 gallons of water, if placed upon a masonry tower 50 feet high will, when full, afford a static pressure of 43 pounds per square inch.

A standpipe 18 feet diameter, 60 feet high, containing 114,510 gallons of water, if placed upon a masonry tower 60 feet high will, when full, afford a static pressure of 50 pounds per square inch.

A standpipe 20 feet diameter, 80 feet high, containing 188,480 gallons of water, if placed upon a tower 70 feet high will, when full, afford a static pressure of 65 pounds per square inch.

A standpipe—steel tank with masonry or brick tower—costs to erect from $6000 to $16,000, if plainly constructed; if the design is ornamental and much cut stone is used in its construction, or an expensive foundation is to be prepared, then the cost is materially increased; but a large number of the standpipes in use throughout the country cost from $6000 to $10,000; a variation in the dimensions and capacity affecting the price.

The tower may be built of shape iron, brick, rubble

or ashlar masonry. Whatever material is used should be of the best and the workmanship first-class, for the weight to be sustained is a heavy one and the tower as a whole structure is subjected to great wind-strains.

When setting the pumps, keep them well down to the water level in the well. A 10-foot lift (suction) is an economical one; an 8-foot lift is even better.

Use a duplex compound pump and condenser of some reputable make, and thus help to keep operating expenses within reasonable limits.

If the water supply will permit it, locate the pumping station as near as practicable to the business centre, where exist the vital interests of a city; then the power to supply water is where the most water is likely to be required; it is also where the greatest need exists for protection against fire. If a city is divided by a stream, have more than one pipe crossing the stream and place the pumping station on one side of the river, the water-tower upon the other. In many cities the water-tower and the pumping station are thus separated for a distance of more than a mile. By means of an electric connection between the two structures, the engineer at the pumping stations can, by pressing a button in the wall of the pump-room, close the valve in the water-tower and thus disconnect it from the pipe system and give direct pump pressure whenever called upon to do so. Use plenty of gates or valves in the pipe system, so that if a break in a pipe occurs, or a hydrant is to be removed for repairs, only a small section of the pipe system need be deprived of water

while the repairs are being made. In the business part of a city it is better to place a gate on the (pipe) hydrant connection, between the hydrant and the street main; then a hydrant can always be removed or repaired without interrupting the flow of water in the street mains.

Never be parsimonious in the furnishings of a water-works system: if such extreme policy be followed it will be found, after the works are completed, that there are several omissions in their construction which must be supplied, and at much greater cost than if adopted at the outset, as they should be. The careful engineer will provide for many things which to the novice seem of minor importance; but the engineer is a man who obtains a livelihood by spending other people's money; so the purse-strings are drawn tightly on him, and later on some one else supplies the deficiencies at a greater cost and nothing is said about it.

Build all structures connected with a water-works system as nearly fire-proof as practicable.

Always subject a pipe system after it is laid, and before acceptance of the work, to a substantial test with the aid of the pump—at least 100 pounds pressure at the hydrant; and hold this pressure one hour if desired. Such a test is liable to show all the weak places in the pipe and expose bad calking. It is much better to find the weak places in a pipe system before the acceptance of the work than afterwards during a conflagration. If under the test a breakage occurs, it should be

repaired and a second test made, and again if necessary until no breaks occur.

Test the valves of all hydrants in the fall of the year before freezing weather sets in, and have them well protected against frost. Test them again in the early spring when freezing weather ceases, and drive down all frost-jackets which may have raised during the winter.

Capacity of Pumps required for Cities of a Stated Population.

Population.	Daily Capacity, Gallons.
1,800 to 3,000	1,000,000
3,000 to 6,000	1,500,000
6,000 to 10,000	2,000,000
10,000 to 20,000	2,500,000
20,000 to 25,000	3,000,000

Most towns and cities have two pumps and two boilers; the pumps are not always of the same capacity. Some smaller cities have but one pump and one boiler. This is not only a risk because of the liability of a breakdown, but there comes a time when pump and boiler must be cleaned or repaired, and then no pumping can be done and for the time being there is no protection against fire.

When considering the adoption of a water-works system, whether for construction by the town or city itself, or by granting a franchise to a company, a map or plan of the entire pipe system and hydrant location should be carefully prepared. To prepare such a plan in a practicable manner the source of

water supply must first be permanently fixed, then locate the site for the pumping station and the water-tower, and if there is a stream traversing and dividing the city, the pipe crossings of the stream should be located. When these points are determined, the pipe lines can be drawn thereon. The map should show also all inhabited blocks in the city, the location of all public buildings, churches, manufactories, etc., and the business blocks of the city should be "hatched," i.e., cross-lined, so that the map will show at a glance all the actual property of the city that is to be protected with hydrants and exactly what streets are to be piped to supply water to consumers. When the map is thus prepared, the hydrants can be located to the best advantage. Place one hydrant at every block in the business centre of the city, also a hydrant at the corner of alleys on every cross street, so that a line of hose can be run along the alley in rear of the stores, where fires most commonly break out. In the residence parts of the city locate one hydrant at every alternate block. Place hydrants on the north and east side of streets, where they will receive the most benefit from the sun's rays in the winter months. The usual number of hydrants placed upon a system is ten to one mile of pipe. This is about the right number in the more densely settled parts of a city; but in the suburbs, where land lots are larger and houses farther apart, seven to the mile is enough; this number gives one hydrant to every 754 lineal feet of pipe.

When the map is entirely completed it should be

formally adopted by the city council and placed on file, and the franchise, if one be granted to a company, should refer specifically to this map in its details and conditions; for future reference it will be invaluable, for it shows the original pipe system and plant of the city's water-works system, independent of its subsequent growth and extensions.

Weight per Foot of Cast-iron Pipes, including Socket and Spigot Ends.

Diameter.	Thickness.	Weight per foot.
4 inches	$\frac{1}{2}$ inch	23 pounds
6 "	" "	33 "
8 "	" "	43 "
10 "	$\frac{5}{8}$ "	68 "
12 "	" "	82 "
14 "	" "	94 "
16 "	$\frac{3}{4}$ "	129 "
18 "	" "	137 "
20 "	$\frac{7}{8}$ "	197 "
24 "	" "	224 "

Note.—Cast-iron pipe costs from $24 to $30 per ton at the foundry. Specials (T's and Y's) cost $50 per ton. Freight from 11 to 18 cents per 100 pounds to points in the Northwest.

The usual length of a water-pipe is 12 feet.

The length of a hydrant stock is 7 feet below the level of the sidewalk curb, unless otherwise ordered by the purchaser.

The valve or gate stocks which cover and protect the valves on the street mains are made 6 feet long, with screw-sleeve attachments, so that the top of them can be adjusted to the grade or surface of the street.

The grade of all streets in a town or city should be established and profiles of the same placed on file in the city clerk's office, and the water-pipe laid, where practicable to do so, to conform to such grades. Unless this be done trouble will arise between the city and the water company whenever a street is graded and the water-pipe thus exposed to the danger of freezing; the water company must lower the pipe, and it generally expects the city to pay for such work where no street grades are established.

It is an open question whether a city council has the authority to convey to a water or a gas company any right whatever to the use of its streets, above or below ground, which entails upon that city expense in caring for or protecting such property as these companies may bury below the street surface. The city had certain rights and authority to grade, level, pave, and otherwise improve its streets before the water company existed, and the granting of a franchise to supply the city with water or gas should not curtail this right in the least particular; if the city must pay for lowering or raising water and gas pipes whenever it grades a street, it certainly is a curtailment of the rights of a city to improve its streets.

Gallons of Water required Daily for Man and Beast.
(German Estimate.)

One person, in summer	20	gallons.
" " " winter	15	"
" horse, average	18	"
" cow, "	13	"
" heifer, "	10	"
" sheep, "	1	"
" hog, "	7	"

Hydrant Pressures required to give Certain Streams of Water of Stated Volume and Efficiency.

Hydrant Pressure, pounds per sq. inch.	Length of 2½-inch Rubber Hose in feet.	Size of Nozzle, Smooth Bore.	Gallons discharged per minute.	Height thrown in feet.	Distance thrown in feet.
50	300	1⅛ ins.	155	53	82
55	300	1⅛ "	164	59	89
60	300	1⅛ "	170	63	93
50	400	1⅛ "	142	45	74
55	400	1⅛ "	152	51	80
60	400	1⅛ "	158	55	84
60	200	1¼ "	182	75	106
70	200	1¼ "	196	85	117
80	200	1¼ "	209	94	128

A MUNICIPAL FRANCHISE.

A FRANCHISE granted by a town or city is nowadays, in its form and terms, the record of a bargain between two parties, whereby the conditions may prove to be exceedingly favorable to the grantee and very onerous and unfavorable to the grantor, or the community the franchise is intended to benefit for a consideration; but frequently the grantor does not discover or realize the true intent or purport of all the conditions imposed until the results are shown by actual working operations. When the franchise is considered and discussed before its passage, the grantee invariably knows of what he is talking and the council, as a rule, does not, it having no previous experience in that particular matter; and many franchises have been granted for gas, electric lighting, street railways, water-works, etc., that were not fully comprehended by any of the council when under consideration; indeed, there are existing franchises which contain conditions that would not be tolerated, nor even considered for a moment, had the grantors their work to do over again. But the grantors in such cases are the people, and the people have only themselves to blame for the bad effects of their bargains: they allowed their representatives to buy goods of a kind and quality with

which they were totally unfamiliar, and although the community may murmur because of the poor results obtained, it must nevertheless foot the bills. The careful, conservative alderman, one who exercises the same good judgment and business tact in public matters that he does in his personal affairs, will hesitate to vote for or approve of any contract or franchise to be granted or let in the interest of his city until he fully understands all the conditions involved and something of the effect they may have upon the community when the instrument is subjected to practical operation.

The legal requirements of a franchise are most generally well cared for, because both parties to the agreement employ able lawyers to frame the conditions; but oftentimes there exists a gap between the legal and the mechanical requirements that cannot be closed—where human and natural laws will not join and make a harmonious whole—because the mechanical part of the franchise was not represented and in connection with the legal part when the document was framed. In such cases the mechanical conditions must in effect be ignored and are inoperative, because they would otherwise conflict with the law, which has a weakening effect upon the whole franchise, creating in the community a feeling of dissatisfaction that exists during the life of the franchise.

There are many instances where municipalities could have obtained better water systems, better bridges and pavements, and for the same money that is expended for poor work or service, had the city em-

ployed a competent* engineer to care for its interests, instead of dealing unadvisedly with the contractor and accepting plans and specifications drawn by him, or a franchise drawn by the would-be grantee, of which the council knew little or nothing. The tendency when granting a franchise is to be too liberal with the terms imposed and at the same time careless regarding the exact nature of those which the same franchise will impose upon the city. A franchise is presumed to convey benefits to a community granting it, and for such benefits the community are generally required to pay, either individually or collectively, as with street-cars and street-lighting. The franchise when in practical operation is expected to produce a sufficient remuneration to the holder thereof to induce him to confer certain benefits upon the community for

* The use of the word "competent" is every way better for the engineer than the word *expert*. All professional men are not experts in their particular calling. When called into court to give testimony upon matters pertaining to their vocation they are generally rated as experts and berated by the opposing lawyers because of this distinguishing title, and in the minds of some persons the word "expert," as applied to professional men, has become synonymous with the word liar—perhaps justly so in some cases. A competent engineer is no more of an expert than is a competent doctor, lawyer, or manufacturer, unless he is a specialist in certain branches of his vocation and well known as such. Neither the city attorney, the city engineer, nor the city physician is rated as an expert, however competent he may be in his calling; but when the outside professional man is called upon to consult with one of these officials upon matters profound or difficult, he is forthwith dubbed an expert, when in a majority of cases he is simply competent.

a specified term of years: should it prove to be unremunerative, it is generally allowed to lapse and the public receive no further service from it, notwithstanding the conditions it contained requiring the continuance of the service; but no lapse occurs if the conditions of the franchise prove to be advantageous and remunerative to the holder and are insufficient and burdensome to the community for which it was created. Under these circumstances the community will bear with it to the end, complainingly of course, unless the conditions become unbearable and relief is sought in a court of law.

Most franchises in their operation impose a twofold tax upon a community: the individual being taxed, for instance, for gas and water for the house, and the city for gas for street-lighting, and water for the hydrants. Street-car service imposes a tax upon the individual alone, and this not quite so voluntary as has been claimed for it: it is not always optional with the business man whether he will ride or walk; his own or his employer's interests may not permit it, because of the time consumed in walking long distances.

Modern appliances and appurtenances seem to be in a constant state of evolution; the best methods and appliances of to-day may become obsolete within a year. This rapid material development has had a marked effect upon municipal improvements, simplifying and cheapening so many of them that they have been readily adopted by the smaller cities, giving them quite as metropolitan an appearance as our largest

cities. This transitory state of material things affecting municipal improvements has also a marked effect on the population of a city: it demands the best and cheapest service of all kinds, and as soon as it is demonstrated that the improved service is better than that which they have, its adoption is an immediate result. Therefore, when a franchise is to be granted for any purpose it should be for a short period of time—about ten years; otherwise it should contain a provision whereby a community may in after years regulate the service performed to conform to the changed and altered conditions of the municipality wherein it exists, and also regulate the price exacted for the service rendered—upon the same principle that long leases of real estate are re-rated in rental price every ten or twenty years. The conditions involved when granting a franchise are matters peculiarly under the care of the municipality, and the council granting it is not only required but bound to act with the highest regard for public interests.

It is strongly advocated by some of the best municipal legislators in this country that the use of streets by companies whose franchises grant such use should be paid for, and not freely donated as is now commonly done. The license fee paid by street-car companies in some cities is a practical illustration of this opinion.

A city granting a franchise at the present time should do so conditionally, and the conditions held in view should be:

A re-rating at stated intervals of prices paid for service rendered;

The termination of the contract by purchase whenever desired, in a fair and equitable manner;

Reserving the right to annul the contract when the service rendered is continuously inferior to the better service required.

When a company seeks to obtain a franchise from a municipality, it does so because it is believed that the results of its operation will be remunerative, otherwise it would not be asked for, and this fact should be borne in mind, as it affords some idea of the value of the franchise asked for.

PAVING MEMORANDA.

STONE paving-blocks are supposed to be made of uniform dimensions, but they are seldom found to be so. The usual dimensions of the granite block are $3\frac{1}{2} \times 6 \times 8$ inches; upon work where the pavers are laying them they will be found not only of these dimensions, but also of $4 \times 6 \times 9$ inches, $3 \times 6 \times 9$ inches, and $4 \times 6 \times 7$ inches. This variation in dimension is not in the least objectionable if all are of a uniform depth of six inches and have parallel surfaces. Sometimes paving-blocks are used which comply with the required dimensions at one end only, and this end is placed upwards by the paver; the lower end of the block may be either wedge-shaped or bluntly pointed, or quite suggestive in shape of a kernel of corn. Such a paving-block, having no flat base to rest on, sinks in the ground, causing many of the numerous depressions seen in pavements. Stone blocks may vary a little in width and not be at all detrimental to the quality of the work. Three blocks placed side by side should not measure in the aggregate more than fourteen inches in width. When granite blocks are set on a concrete base the joints are generally filled with a mixture of hot tar or pitch and gravel.

The paving-bricks now offered for sale are $2\frac{1}{4} \times 3\frac{1}{2}$

$\times\ 7\frac{3}{4}$ inches; they are burned harder than the ordinary brick, and when struck smartly give a metallic ring like vitrified sewer-pipe. In pavements they are generally laid in two courses or layers: the lower course is laid flatwise, the length placed longitudinally with the street; the upper course edgewise, the length placed transversely with the street. An interstitial filling is used in the joints composed of hot tar and coarse sand, or asphaltum and coarse sand, or some patent compound prepared for the purpose, of which there are several kinds on the market.

Wood paving-blocks should be as nearly of uniform diameter as practicable. The lesser diameter should be four inches, and the greater eight inches. The pavement will be the better if all the larger blocks are split into two parts and then laid among those of lesser diameter. A block eight or nine inches in diameter, surrounded with blocks of much less diameter, will make in time a noticeable elevation in the pavement, the smaller blocks wearing away or being crushed down by the traffic, leaving the broader block isolated and higher than those about it. Six inches is the usual depth of block used, although blocks of five inches depth are not uncommon. The blocks must be set quite loosely in place, for when wet they expand so much as to lift from the foundation. Select the largest blocks, split them in two, and place the split sides against the curb, which forms an excellent joint: the large blocks are thus removed from the middle of the street, where those of a uniform size should be used.

The Telford-Macadam pavement as now constructed is substantially made by first grading, surfacing, and rolling, in a very thorough manner, the earth road-bed upon which the stone covering is to be laid; the first layer, of broad, flat stones, is then placed by hand, the stones set closely together, with the base of each downwards; the joints are then filled with spalls wedged and sledged solidly in place. Upon this prepared surface the coarser stone from the crusher is laid, covering it with coarse gravel as a binder that it may be well rolled; upon this a third layer of the medium-sized stone from the crusher is spread, and upon this third layer is put the finer stone from the crusher; this surface is then wet thoroughly and rolled until it is very compact and firm.

Before any paving or macadam is laid, the subgrade or earth road-bed which is to receive the wearing surface of the road or street should be graded so as to insure good drainage and then be well and compactly rolled; for if this subgrade yields in places under future conditions of weather or traffic, the surface of the road will yield correspondingly, and every such depression will be plainly indicated by a puddle on the surface in wet weather,—and it is the puddles which make our bad streets and roads.

General Gillmore said that a good, well-built road was also a good roof. This comparative idea should be borne in mind by the builders of roads.

BRIDGES.

THE bridges generally built by a municipality are of two kinds: the swing-bridge for navigable streams, and the fixed or permanent bridge for unnavigable streams.

If a swing-bridge is desired, the first thing to consider is the width of the channel upon either side, which should be wide enough to permit the passage of the largest boat that navigates the waters of that locality. Sixty feet is the usual width for draw-channels in the cities located on the shores of the great lakes, although there are several draw-channels in the Northwest which are sixty-six feet wide, and this is not an undesirable feature for the larger vessels which require more leeway. Side-wheel steamers require a greater width of channel than other boats, but such boats are now principally confined to river traffic; hence the width of a draw-channel is a matter of local consideration. For a swing-bridge there is nothing gained by making it wider and longer than is absolutely necessary; the heavier the bridge the harder or more difficult it is to turn, and such bridges are most generally turned by hand.

The roadway of a swing-bridge is generally made 18 feet wide, and the sidewalks 9 feet 4 inches wide from the inside of the roadway curb to the extreme edge of the sidewalk floor; but from this width of

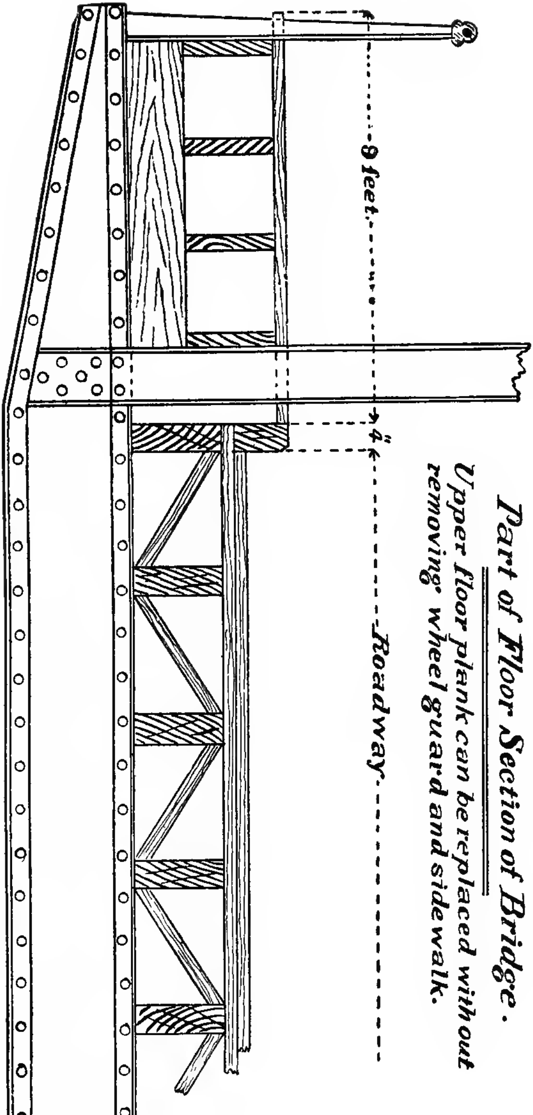
9 feet 4 inches must be deducted the width of the roadway curb, the thickness of the truss post, and the space occupied by the sidewalk rail, which in the aggregate amounts to about 2 feet, thus leaving a clear width of sidewalk of 7 feet 4 inches. The aggregate width of the two sidewalks and roadway is 36 feet 8 inches; the width of draw-seats at each abutment is 3 feet 6 inches. The pier protection in mid-channel should be built at least 3 feet wider than the extreme width of bridge, to afford a safe protection to the draw when swung. The summing up of these dimensions will give the total length of draw required for a channel 60 feet wide upon either side of the bridge:

Width of bridge....................	36 feet 8 inches
Two draw-seats.....................	7 " 0 "
Pier protection, outside of draw.....	3 " 0 "
Two channels, each 60 feet..........	120 " 0 "
Length of bridge.................	166 feet 8 inches

If the width of the bridge is increased, the length must be increased correspondingly, otherwise the width of channels will be decreased.

The iron or steel bridge is now almost universally adopted by towns and cities,* but the wooden bridge floors have not yet been relegated to obscurity, along

* The first all-steel bridge was that over the Missouri River at Glasgow, Mo., built by Gen. W. S. Smith, civil engineer, of Chicago, Ill., and completed in 1880. Now the steel bridge is met with not only in cities, but on country highways.



Part of Floor Section of Bridge.

Upper floor plank can be replaced without removing wheel guard and sidewalk.

with the wooden truss, as they should be. The fixed or permanent bridge can be made of almost any reasonable length desired, and without any consideration of the weight and difficulty of turning which is involved in the construction of the swing-bridge. Its width of roadway can be made as desired, for two or four vehicles to move abreast of each other, or it can be made the full width of the street or streets it is to connect.

If a bridge floor is to be of wood, the roadway flooring should be of double thickness, and the upper thickness (called wearing plank) laid independently of the guard-rail and sidewalks, that it may be renewed when necessary and without disturbing the sidewalks. Sidewalks will last much longer than any surface plank that can be laid upon a bridge roadway. This method of flooring is applicable to either the swing or fixed bridge.

The foundation for a masonry centre pier for a swing-bridge, or for a pier placed in mid-stream to connect two spans, can be made by sinking a caisson below the river bottom upon stable soil or rock and filling the same with concrete to the water-level. A pile sub-foundation may be made by driving the piles closely together within the area desired, and cutting them off at a depth of about four feet below water-level; then place a water-tight caisson on the piles, and commence laying the masonry on the floor of the caisson. The interstices of the piling should be well filled with broken stone before the caisson is placed thereon. If the subsoil below the bed of the

stream is soft and mucky, or partakes of the nature of quicksand, and is of such depth that piling when driven into it will not stand sufficiently firm and steady to support the proposed structure, then pneumatic caisson work will be necessary, and the plans, specifications, and work itself should be placed in the hands of a competent engineer.

Cribwork made with sheet-piling and walings, two rows, with an intervening space about 18 inches wide, packed solidly with gravel to exclude water, costs from $6 to $10 per lineal foot, according to the depth of water in which it is built. Pneumatic caisson work costs about $2.25 to $3 per cubic foot, measuring the entire bulk of the caisson. A caisson constructed on shore and floated to place and set on a pile support, to a depth of four feet, more or less, below water-level, costs from 30 to 40 cents per cubic foot. Such caissons are generally built of heavy pine plank.

Piles that are to be driven below water-level may be of pine, cedar, tamarack, or elm; oak is preferable where they remain partially above ground or water, and in this case they should be stripped of their bark.

Piles when driven should be ringed unless an iron cap is used, and should not be forced into hard ground to their injury. The driving should stop when they cease to move under the blows of the hammer. Piles cost from 16 to 25 cents per lineal foot; the cost of driving varies from 15 to 20 cents per foot. Foundation-piles should girt not less than 36 inches midway their length.

It pays well to select all lumber intended for bridges, using only the best. Although the first cost is thereby much increased, there is an actual saving of money in the greater durability of the work. All bridge lumber and timber is necessarily long, consequently is the most expensive; and the renewal of a bridge floor is not only an expensive job, but is an annoyance to the public and an obstacle to the business interests of a city. Norway pine should not be used on bridges; it checks badly, which diminishes the strength of the stick.

When a municipality can afford to do so it should build its bridges with iron or steel floor beams and joists—in fact, make all of the structure that is practicable of steel. If a fixed or permanent bridge, the floor may be of asphaltum; but if a swing-bridge, a plank floor is necessary, as paving of almost any kind will load the structure too heavily, unless steam or electric power be used to turn it.

When advertising for proposals for bridge construction, divide the work, requiring separate bids for the substructure and the superstructure; because some bridge builders do not build substructures, besides the council will have the advantage of a greater number of bids to choose from.

When a municipality grants an electric motor line franchise, a clause should be inserted requiring the company to furnish power to turn all drawbridges which are traversed by the cars of the company. Of course the city must furnish and keep in repair the necessary electric cables and apparatus for turning the bridge.

METHODS OF ASSESSMENT AGAINST REAL ESTATE.

LOCAL customs and laws have produced different methods of assessment. The prevailing opinion nowadays seems to be that "every tub shall stand upon its own bottom"—or, in other words, every piece of property on a street shall pay for one half the cost of all improvements done on the street; and this rule is perhaps as good equity in such matters as can be practised.

If it is desirable to raise a general sewer fund, legislative authority to do so may be obtained, provided that the city charter does not warrant the raising of such a fund; or a community may ask for an election, that a popular vote may give the council authority to issue bonds the sale of which will afford the funds desired.

Sometimes a general city tax can be levied annually to pay for sewers built during the year. A general sewer fund is in most instances necessary, because without it the sewers at street intersections cannot be built, and private property can rarely be assessed to pay for such construction; therefore it is necessary that the city have funds to pay its share of the construction, whether it be sewers or pavements, otherwise the property owners cannot have the benefit of such improvements.

It is customary for the city to pay from the general fund:

For sewer work—the cost of main and intersecting sewers, man-holes, catch-basins, lantern-holes, flushing tanks and outfalls; also sewers at all street intersections and along the frontage of all city public buildings and parks.

For street work—pavements and crossings at street intersections; pavements along the frontage of city public buildings and parks.

For bridges—all bridge and viaduct work between dock lines or meander lines, unless the construction involves a change of grade; then the city should pay for all the work done; also for all culvert work done on streets within the city.

It is very unusual for a city to pay from the general fund the cost of curbs and sidewalks at street intersections; this is invariably charged to the property located at each corner, respectively.

Where a city builds its own system of water-works the entire cost of the system is paid from a general fund provided specially for the purpose. The sale of water to the inhabitants is about the only method that has been adopted to reimburse the city for such an improvement; it is for this reason that the revenues from the water-works system are in most cities kept separate from other revenues. The revenues thus received are used to liquidate the indebtedness caused by the construction of the system and for repairs and extension of the pipe-lines, also for operating expenses.

When the revenues exceed the total expenses, the rates to consumers are generally reduced.

In many cities the property owner is charged only with the cost of laying an eight-inch sewer, no matter how much larger in diameter the sewer may be that was laid on his street. If a larger sewer was laid, the city bore the expense but charged the cost of an eight-inch sewer to the abutting property owners. Thus property assessments for sewer construction per lineal foot of frontage never exceed the cost per lineal foot for laying an eight-inch pipe.

It is also a common practice to assess each lineal foot of frontage of the entire city the sum of one dollar or more. This sum the city can draw upon for all sewer work, including the street sewers, which are a benefit to the abutting property; but when any lot has paid this sum of one dollar per lineal foot it is exempt from further assessments for sewer work. It will sometimes require three or more partial assessments, at intervals of several years, before the whole assessment is collected.

Where cities because of their topographical conditions are naturally divided, it is better to maintain these divisions when the sewerage system is planned, naming the different divisions "District A," "District B," etc. Where these districts are formed they are distinct from each other in all matters pertaining to sewer construction; each district can provide sewers for itself without interference from the residents of another district.

There is another method of levying assessments against property for street improvements founded on areas of property. Each lot is assessed one cent, more or less as may be required, per square foot of area contained within its boundary. This method of assessment may be used for the payment of sewer construction or for paving. A lot 50 feet wide and 120 feet deep contains 6000 square feet; at one cent per square foot the assessment would be $60.

In making assessments for improvements it is customary to deduct about one third of the total assessment levied against a corner lot.

Assessments made against church property and other institutions (not public) are paid by the trustees or other legal custodians of such institutions.

MISCELLANEOUS MEMORANDA.

CONDENSING-ENGINES require 20 to 25 gallons of water to condense the steam evaporated from one gallon of water.

A COLUMN OF WATER one inch square and $2\frac{31}{100}$ feet high will give one pound (static) pressure per square inch.

A CUBIC FOOT OF WATER at a temperature of 60 degrees (Fahrenheit) weighs $62\frac{367}{1000}$ pounds ($= 7\frac{48}{100}$ gallons).

AN AREA 100 FEET SQUARE contains $\frac{23}{100}$ acres. To find readily the quantity of land in a given area, reduce it to square feet and multiply the sum by 0.23.

WEIGHT OF SUBSTANCES.

One cubic	foot of	granite weighs	160	lbs.
"	"	limestone weighs	130	"
"	"	sandstone weighs	125	"
"	"	brickwork weighs	125	"
"	"	gravel weighs	84	"
"	"	sand (moist) weighs	84	"
"	"	clay (moist) weighs	90	"
"	"	earth, common loam, weighs	75	"
"	"	earth, common loam, moist, weighs	90	"

One cubic foot of	elm, dry, weighs..........	35	lbs.
" "	pine, white, dry, weighs....	30	"
" "	pine, yellow, dry, weighs....	40	"
" "	pine, Southern, dry, weighs	60	"

For green lumber add one fifth the weight given for each kind, respectively.

MASONRY AND BRICKWORK.

1⅛ barrels of lime and ⅝ of a cubic yard of sand will lay 1000 brick.

1600 to 1800 brick laid is a day's work for one man, properly attended.

1¼ barrels of lime and 1 cubic yard of sand will lay 100 cubic feet of stone.

One man and one tender will lay 150 cubic feet of stone in one day (rubble masonry).

1¼ barrels of cement and ¾ of a cubic yard of sand will lay 100 cubic feet of stone, rubble masonry.

FOR MAKING CONCRETE.—Mix one barrel of cement with 10 cubic feet of sand; cast it upon 25 cubic feet of broken stone; moisten the mass with water applied with a rose sprinkler; overturn twice with shovels, then cast into trench in layers not exceeding 8 inches thickness and *ram* well in place. Rammers should weigh about 12 pounds. Do not drench the concrete with water when mixing it.

COAL.

Anthracite.

Lump coal contains 36.19 cubic feet per ton of 2000 pounds.

Egg contains 34.63 cubic feet per ton.

Nut contains 34.32 cubic feet per ton.

Pea contains 37.60 cubic feet per ton.

Bituminous Coal.

Indiana block contains 45.61 cubic feet per ton of 2000 pounds.

Illinois coal contains 42.35 cubic feet per ton.

Ohio cannel contains 40.66 cubic feet per ton.

Hocking contains 40.56 cubic feet per ton.

Coke contains 76.04 cubic feet per ton.

GRADES OF SEWERS.

THE grade or inclination of a sewer is an important feature of a sewer building. It is not wise to lay sewers at such excessively steep grades that the fluids will flow rapidly away, leaving the solids stranded as it were for awhile, to be shoved or carried along farther by the next influx of fluid, for the flow of sewage is not a certain constant quantity, only in main sewers which receive their flow from all the minor sewers, and even in main sewers the volume of flow varies with the hours of the day in accordance with the domestic work of the many households which supply it.

If the grades are too light or there is too slight an incline, there is more danger of clogging and stagnation, which will cause offensive odors and the accumulation of gases within the sewer system. As a rule, what is sufficient to drain the street surface is more than sufficient to drain the sewers.

Where the combined system is used the watershed area and the annual rainfalls are the governing factors. Locality, therefore, makes a great difference in this respect: the larger the watershed the larger must be the sewers. Where the ground takes up much water and where the streets are unimproved, one fourth of an inch rainfall per hour is a fair basis for determining

the size and grade of the sewers. In a city where all the streets are improved (paved or macadamized) the absorption is very small, and one-half inch rainfall per hour is a safe basis for computation.*

The shape of a sewer affects its velocity, and the size affects it even more. An elliptical or egg-shaped sewer gives a greater velocity to the same volume of sewage than if it flowed through a round pipe of the same sectional area; the reason for this is that there is less wetted perimeter (i.e., wetted pipe surface) in the former than in the latter to the same volume of sewage, and this wetted surface retards the flow in direct proportion to its area. A sewer five feet in diameter with a fall of four feet per mile, and a sewer two feet in diameter with a fall of ten feet per mile, have the same velocity that a sewer ten feet in diameter with a fall of two feet per mile has. A sewer having a velocity of three feet per second is sufficient; five feet per second is considered an extreme velocity.

Where the separate system is used the questions of watershed areas and rainfalls are not considered. In this case the sewage of the city only is to be cared for. Here the population of a city, present and prospective, which is to be served with house-drainage is the consideration of the engineer who makes the plans for the system.

Whichever system is adopted, the grades and sizes

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* The rainfall in Wisconsin during the months of May and June, 1892, amounted to fifteen inches. This is equal to nearly one half the annual average rainfall for the decade of 1880–90.

of sewers are not a matter of guesswork but of mathematical calculation, good judgment, foresight, and skill; and every locality where sewerage is contemplated must be studied and treated according to the conditions found, if an efficient system, economically built, is desired.

The centre of all streets for a width of at least ten feet (located longitudinally with the street) should be reserved in all towns and cities exclusively for sewers. This reservation should not prevent the surface of the street from being used for any legitimate purpose or traffic. It simply reserves that much of the street from occupation by water, gas, and other pipes, or obstructions to sewers and sewer grades. A sewer in operation is a gravity conduit, while other pipes or conduits are not and a grade is not essential to their operation; with a sewer, grade is everything; therefore a sewerage system should have first place in municipal consideration and foresight.

FIRE LIMITS.

THE fire limits of a city should be the corporate limits, but for many reasons they are not so defined. The customary practice is to establish a fire limit which encloses the business centre of a city and allows the residence portion to build as it pleases and fight fires when compelled to. In most cases the only difference existing between the inside and the outside of the fire limit is that only brick or stone structures can be erected within the fire limits, and no restrictions whatever are placed upon building methods outside of it; consequently the fire limit is surrounded with a dense mass of kindling which, if ignited and favored with a brisk wind blowing from the right quarter, will burn to the corporate limits—the only fire limits it recognizes.

The actual reason why the ordinary fire limits of a city are so contracted is, that it entails upon owners of property within such limits more expensive buildings. The possibilities of obtaining lower rates of insurance and securing less danger from fire are minor considerations with many. The overwhelming depression, private and public, which falls upon a community that has suffered a sweeping conflagration is not known or appreciated until experienced. Cheap buildings are desirable adjuncts wherewith to boom a town, but they add nothing to its permanence. The logic de-

duced from our present building laws is well illustrated by the remark of an alderman of a city that had recently suffered from a great fire: "It is better that the homes of the people should burn rather than the shops and factories which give them employment"—which is practically saying, "Of two evils choose the least." Yet when a fire sweeps everything, homes, shops, factories, and all, directly there is a strong demand upon all sides for better and more stringent building laws. There is an underlying principle of selfishness, or it may be said avariciousness, which controls and defines the area of a fire district in cities. Builders as a rule will erect buildings which will give the highest remuneration upon the investment, and the rule as applied is: a building erected on a certain lot and costing $4000 will return $400 per year to the owner, and a building erected upon the same lot, and of the same dimensions, which costs $3000 will also yield $400 per annum. The established fire limits compel the erection of the higher-priced building.*

The principles of fire-resisting construction and fire limits cannot be very successfully maintained against the percentage principles of investments; they are the strongest in times of disaster.

* In less than three weeks after the great fire in Milwaukee, Wis., of October 28, 1892, the burnt district, which had been previously covered with frame or wooden buildings, was again dotted with wooden buildings which had been moved there by property owners; one owner taking out four permits at one time for moving wooden houses thereon. Yet there existed at the time a popular demand that this burnt district be incorporated within the fire limits.

BUILDING LAWS AND ORDINANCES.

EVERY city in this country that has been visited by a disastrous conflagration has immediately thereafter promulgated more stringent laws and regulations regarding the construction of buildings, and this fact seems to indicate that few if any of our cities have building laws that are adequate and practical, or else they are not properly enforced by the authorities.

All of our larger cities have in force laws and regulations governing the construction of buildings of different kinds designed for different uses, with inspectors appointed whose duties are to enforce these laws. These building laws require that the doors of public buildings, factories, and assemblage halls shall open outwards; that fire escapes or ladders shall be provided for hotels, office buildings, etc. To insure strength of walls, certain thicknesses of wall are defined for each story and the safety loads for floors are prescribed, yet in spite of all precautions communities are often horrified at the great loss of life incident to a conflagration. In most instances the cause which led to the loss of life was bad construction—perhaps weak construction is a better expression, owing to the niggardly economy of the builder, who will erect an 8-inch wall

when it should be 12 inches thick, and support floors with posts 6 × 6 inches cross-section when they should be twice as large. The strength of all kinds of building material, where used to carry certain loads under specific conditions, is readily determined by the competent architect and engineer, and it should be made a criminal act for a builder to erect buildings whose walls and floors have not been passed upon and approved by competent judges. The building laws of most cities are supposed to insure safe construction in this respect, but in very few cities are such laws rigidly enforced. It is commonly said that an efficient building inspector has a short term of office, and there is more than a grain of truth in the saying; every bit of poor construction which he condemns makes the owner thereof his implacable enemy, and the inspector is sooner or later "worked" out of office.

The use of anchor-bolts for uniting floors and wall together is the worst sort of construction and should not be tolerated. The specious plea for using such bolts is that the floors thus bolted to the walls tend to stiffen them and thus make them safer. This is undoubtedly true as affecting a weak wall; any prop will strengthen a weak wall, but a strong wall needs no extraneous support. In reality the anchor-bolt makes a building unsafe and more dangerous to life and property should it take fire. If the walls of a building are not designed with sufficient strength to stand safely without the extraneous and doubtful stiffness which

the floors will afford, then their erection should not be permitted. Builders of the Budensieck kind defend the use of anchor-bolts because they tend to strengthen the walls of a building: it is a great pity that such builders cannot be deprived of the use of the anchor-bolt. When buildings of this kind take fire they are unsafe to approach; firemen dare not enter them nor mount the walls, and a fire-marshal would be justified in allowing such buildings to burn to the ground. If the walls of a building are designed and built of proper strength and stiffness, the excuse for using anchor-bolts is removed.

The following tables show the usual thickness of wall required for buildings at different heights or stories:

For Business, Manufacturing, and Public Buildings, Sixty Feet or more. Thickness in Inches.

Outside, Party and Division Walls.	Basement.	Stories.							
		1	2	3	4	5	6	7	8
One story....	16	12							
Two stories..	16	12	12						
Three " ..	16	16	12	12					
Four " ..	20	16	16	12	12				
Five " ..	24	20	16	16	12	12			
Six " ..	24	20	20	16	16	16	12		
Seven " ..	24	20	20	20	16	16	16	12	
Eight " ..	28	24	20	20	20	16	16	16	12

For the same Class of Buildings as for previous Table less than Sixty Feet deep. Thickness in Inches.

Outside, Party and Division Walls.	Basement.	Stories.							
		1	2	3	4	5	6	7	8
One story....	12	12							
Two stories..	16	12	12						
Three " ..	16	12	12	12					
Four " ..	20	16	12	12	12				
Five " ..	20	16	16	12	12	12			
Six " ..	24	20	16	16	12	12	12		
Seven " ..	24	20	20	16	16	12	12	12	
Eight " ..	24	20	20	16	16	16	12	12	12

If the walls are built of rubble masonry, or are faced with stone, an increase of 4 inches in thickness should be added, also an increase of 4 inches should be made in all cases where the walls are over 100 feet long, unless there are cross walls of equal height.

Buildings erected for the storage of petroleum or fluids of like nature should be constructed as follows:

Walls should be 16 inches thick and not more than 16 feet high, made of brick; the floor to be of fire-proof paving or concrete upon the ground, level of floor not to be above street grade. Roof to be of metal or best composition roofing; fire-wall all around 8 inches thick and not less than 18 inches high. It should be built without cornice of any kind.

There does not seem to be a good, practicable method for chimney construction provided in any of the building ordinances which the writer has read. Most of them commence by saying that "no chimney

shall be built with walls less than 4 inches thick, and no flues to be less than 8 × 8 inches." This is poor enough construction for any chimney, and the ordinance presumably deters the builder from setting his brick edgewise when he builds his chimney.

There should be a standard chimney, well defined in dimensions and construction, for each class or kind of houses erected in cities, because the "defective flue" is the principal cause of fires in all cities. It is a serious risk to build a fine house with chimney walls only 4 inches thick. Bituminous coal, and all coal which contains more or less sulphur, will in time destroy the lime-mortar in the joints of a chimney and render them as porous as a sieve; for this reason the chimneys of all buildings erected in cities should be lined either with clay pipe, terra-cotta lining, fire-brick or cast-iron. Plastering the inside of a chimney is not sufficient protection where coal is burned. If dwelling-house flues were lined with common brick placed edgewise within the 4-inch walls, it would be a vast improvement upon the average dwelling-house chimney; the walls would then be about 7 inches thick and the joints would alternate, thus making it a safe flue within the house.

In this country there does not seem to be any personal responsibility connected with weak and defective construction of buildings, we see enough of it so far as sidewalks, bridges, etc., are concerned, but the owner of a weak, badly constructed building goes scot-free should its destruction damage other buildings.

Contractors are often held liable for injuries received by an employee on the work and have to pay a smart sum of money in consequence; yet that same building may afterwards take fire because of a defective flue, and in burning destroy all the adjacent buildings, but the owner of the building is never held liable for the destruction of the adjacent buildings because of the defective flue. A French court a few years ago held a property owner liable for the destruction of adjoining property by fire, caused by a badly built chimney erected by the defendant. With all our love of justice and fair play, we Americans have not yet reached this degree of equity.

FIRE-RESISTING CONSTRUCTION.

WHILE we cannot erect buildings that are absolutely fireproof, yet we may erect buildings of brick and iron that are less liable to damage beyond repair, and we can erect wooden buildings that will resist fire long enough to enable a fire department to save them and their contents from a total loss, and without doing serious damage to adjacent buildings. Soon after the second great fire in Chicago (July, 1874) a prominent builder of that city was asked, "What are the essentials of a fireproof building?" The builder's sententious reply was: "Build of brick and iron, use the least quantity of stone possible, leave out all doors and windows, and put nothing in the building." His comments upon the use of materials are the strong points of fire-resisting material. Our best building stones, limestone and granite, are the poorest fire-resisting materials we can use in a building, for they will absolutely go to pieces under great heat. A brick building to be fire-resisting should have all its iron columns and beams covered with asbestos or other non-heating substances: to leave such columns and beams exposed is to insure their destruction should the building take fire. Its windows should be protected with metal shutters, and its roof slated or metal-covered. Elevator openings and stair-

ways should be located outside its walls, thus having no openings in the floors within the building. The floors should be laid solidly with two thicknesses of plank, with an intervening thickness of tin or galvanized sheet-metal placed between the plank. The roof should be made of three-inch plank, lap-jointed, and then covered with slate or metal. If the basement is to be used for any purpose that causes an accumulation of inflammable goods, such as a printing establishment would have, the basement walls and the pedestals supporting the columns should all be of brick. Wooden columns will stand a hot blaze for some length of time. They are far safer than ordinary cast-iron columns; in fact, they are better than iron columns unless the iron is covered with some non-heating substance. A wood column burns slowly when subjected to a flame, and will char slowly when subjected to heat alone; while an iron column will soften and weaken when subjected to either heat or flame,* and if a stream of cold water strikes a heated iron column it will surely go to pieces.

There is no building that firemen dread more than one built with light brick walls, a stone-veneer face, the front and floors supported with cast-iron columns

* At the great fire in Chicago papers of tacks and kegs of nails were fused into solid masses and retained their package shape, showing that intense heat (not flame) had fused the iron into a mass before the package covering was burned or destroyed, otherwise the package shapes would not have been preserved. The iron-work of a carriage melted and dripped as if it had been tallow, while parts of the wood of the running gear still retained their shape although much charred.

unprotected. A building of this kind is a menace to life and property when on fire, and in some respects worse than a wooden-building.

Wooden buildings to be fire-resisting should be enclosed or sheeted outside of the studding; have no elevator or stairway openings within the building, and the floors and roof built as described for brick buildings (excepting slate covering). The ceilings, walls, joists, studding, and all other exposed surfaces within the building should be well whitewashed, which makes the fibrous surface of the wood less liable to quick ignition when a fire occurs.

In brick buildings wire or metallic (corrugated) lathing should be used upon which to plaster the walls and ceilings. All doorways should be surfaced with tin, and the doors themselves covered, both sides, with the same metal. All chimney-flues should be lined with either clay pipe or fire-brick from the bottom to the top of the chimney. A hollow cornice of either wood or iron should not be built, a simple brick finish is better, or a terra-cotta cornice if ornamentation is desired.

When wooden columns are used they should be bored through the centre longitudinally (1½ inch bore) and half-inch holes bored transversely at the top and bottom, to prevent dry-rot. The cast-iron caps for the tops of the columns should have a projection to enter the bore of the column, and the area of the caps should be about three times the cross-section of the wooden girders.

Care must be taken also to prevent dry-rot in the thick flooring, when it is the intention to plaster beneath it by nailing the lath to furred projections.

Cross-walls should occur in the building as often as convenience for use will admit; if none can be built, the walls must be strengthened with substantial pilasters. To go farther into the details of fire-resisting construction would encroach on the specifications which the architect should furnish to the builder. The foregoing items are given to define the essential features of fire-resisting construction.

MUNICIPAL BONDS.

THE issue of interest-bearing bonds for the purpose of providing funds for the prosecution of public improvements is a matter of much importance to a city, and demands great deliberation as well as the exercise of good financial judgment. While the finances of a city may be in such excellent condition that its bonds when issued for a reasonable amount make a really good, sound investment, yet sometimes the methods of procedure in preparing the issue are so irregular and careless in their details that the bonds do not command a premium, nor even find a ready sale, as they otherwise would had the work of the council been better done.

The issuance of bonds by a council should always be correct in its minor details, and conform strictly to the law by which the issue is governed.

When permission has been granted a council by the affirmative vote of an election to issue bonds, the law authorizing such election and the result as shown by the affirmative and negative votes cast should be printed on the face of the bonds; also the act passed by the council authorizing the issue, with all the necessary dates. These statements are relatively the same as an abstract of title to real estate, which the pur-

chaser can verify or not—as he chooses. Some cities also make a statement, on the bonds which they may issue, of their taxable wealth and property, and the population of the city.

The tendency of the average council in many of our smaller cities is to such paucity of record, and meagreness of description of council proceedings as oftentimes to subject the city to discomfiture in suits at law. The records of proceedings of a council are as valuable to the city it represents as are the recorded transactions of a counting-room of a mercantile house; therefore the same degree of care and accuracy should be observed when noting them.

The denomination of the bonds is also matter of consideration: if of large denomination, they will in most instances be bought up by bankers or brokers of distant cities; very few, if any, are taken up by the home capitalist, the denomination being too large an investment for him; if the issue is made in small denominations the citizens at home, of small as well as large means, may absorb the entire issue. The great city of Chicago found a ready sale of its bonds in denominations of $50, bearing an annual interest of 3 per cent. Bankers and brokers generally prefer bonds of large denominations and long-time periods before maturity. A bond issue should not be made with conditions of payment that will prove onerous to a city. If the bonds are payable in instalments, the period of time between them should be at least two years, especially if the instalments are very large,

although the creating of a sinking fund to meet large payments on long periods of time is quite as onerous. The taxpayer generally prefers an alternate year for a breathing spell, when no special tax is levied.

There are no better securities in the land than the bonds issued by a thoroughly solvent, well-governed municipality, and its long-time bonds are much sought after by investors; such bonds will find purchasers a long distance from home.

In the West, and in fact all over the country, the rate of interest on money has been of late years steadily decreasing. We have seen the interest on Government bonds drop during the past twenty years from 7 per cent to 2 per cent. Many cities in the West that have been paying 7 per cent on their railway bonded indebtedness for the past twenty years can now borrow money at 5 per cent, and not a few have borrowed at 4 per cent. Since cities have ceased donating bonds to railway schemes, and have had legislative restrictions placed upon them limiting the amount of bonded indebtedness they can incur, the facilities for borrowing money have become greater, and the rate of interest paid by municipalities has been lowered. Cities which twenty-five years ago "cheerfully" gave three hundred thousand dollars in bonds, bearing interest at 7 per cent annually, to the furtherance of some railway project, nowadays consider it a very serious matter to issue, for the construction of water-works or sewerage, fifty thousand dollars' worth of bonds, bearing an annual interest of 5 per cent.

Judging from the past, it is fair to suppose that the future rate of interest will be lower than now, and not a few able financiers believe that the general rate after another decade has passed will be about three per cent annually. Taking this view, let us suppose that a certain city desires to issue bonds to the amount of forty thousand dollars. Will it not be good policy to issue the whole amount of forty thousand dollars redeemable in ten years at one payment, the rate of interest being 5 per cent? If at the end of ten years the city is unable to redeem them, or desires to defer their redemption because of other and more pressing necessities, it can refund the whole amount at the same rate of interest, or at a lower if the general rate throughout the country has dropped to the anticipated 3 per cent.

Certainly, if the decrease in rate of interest during the next twenty years corresponds to that of the last twenty, it will be unwise for any city to issue bonds for a longer period than ten years. The high rate of interest paid by Western cities on long-time railway bonds during the past thirty years demonstrates the folly of issuing a long-time bond. Perhaps the indications of a future low rate of interest is one reason why the long-time bond is preferred to one that is shorter lived.

CULVERTS.

A CULVERT is most generally built of wood when it should be built of either stone, brick, iron, or sewer-pipe and these materials are fast superseding the wood culvert.

Sewer-pipe twenty-four inches in diameter is about the extreme size that can be used for this purpose. A brick culvert thirty inches in diameter can be built as cheaply as an iron-pipe culvert can be laid of the same diameter. If pipes are used, end protection walls must be built to prevent the washing away of the earth at the ends of the pipe.

Large-span culverts, where sufficient height can be had, can be arched and built of stone; but if there is not sufficient height for an arch, two masonry walls can be erected and steel I beams (twelve or fifteen inches depth—according to the length of span) placed upon them, the ends of the beams built into the masonry flush with their upper surfaces, then floor the structure and erect railings upon either side. The bed of the stream, beneath culverts of large span, should be paved with stone to prevent scouring in flood seasons; the paving-stones should be not less than twelve inches in height. Never set the walls of a

culvert on the paving: to do so is to invite their destruction.

The distance between culvert walls allowed for the flow of water should never be less than the extreme width of the stream it spans; make the distance more rather than less. More width is required for the discharge of water than when the "oldest inhabitant" first saw the same stream. As the streets are graded, gutters are paved and many street surfaces are wholly paved, there is a greater influx of water received into the bed of the stream and in a much shorter period of time than when it was a winding meadow brook, half choked with weeds and rushes, and the verdure-covered land held much of the rainfall for evaporation and absorption by the earth. Under better conditions of streets and areas the rainfalls will cause the water to rise rapidly in the stream and to a greater depth than before, and it will fall rapidly if the bed of the stream has been cleaned, straightened, and otherwise improved, as it should be to prevent damage from high water. If the area of the watershed drained by a stream is computed,—which can be easily done,—there is no reason why the width of a culvert opening should be matter of guesswork; the sectional area and the fall of the stream are also easily determined. With these essential factors on hand the local engineer can readily determine how wide the opening of the culvert should be, basing his calculation upon a heavy rainfall upon snow-covered, frozen ground,—a condition or conditions which will give the

greatest fluctuation. A heavy rainfall at the close of a protracted season of rain will also require great capacity of discharge. A one-inch rainfall upon one acre of ground is equal to 27,225 gallons of water; allowing a loss of 25 per cent of this quantity by evaporation and absorption, there is still 20,418 gallons to be cared for under ordinary conditions and circumstances.

PLANS FOR A CITY HALL.

When the building of a city or village hall is contemplated and the plans are in the formative stage, the first thing to be considered, when the site has been determined, is the convenience of rooms, one with another, relatively to public affairs; that is, particular rooms or offices most frequented by the public should be easiest of access, and be located so as not to discommode those who occupy rooms less frequented. For instance, the rooms of the city clerk, treasurer, and chief of police or marshal should be easiest of access, because they have constant business with the public more than other city officers.

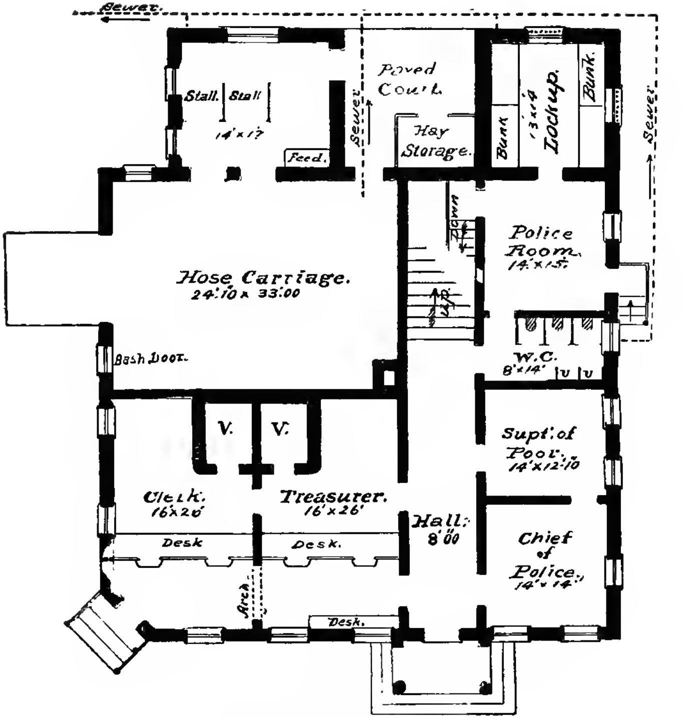
The accompanying plans of the first and second floors of a city hall are shown, not for an architectural consideration, but merely to determine the best arrangement of the various offices suitable for their purposes.

The duties of the city clerk and treasurer are almost identical—at least their work is quite interdependent—consequently their office rooms are placed together; each room has its own vault, and the rooms can be used *en suite* or not—during tax paying time it will be quite convenient to use them so. The corner entrance affords direct access from the street and the desk-

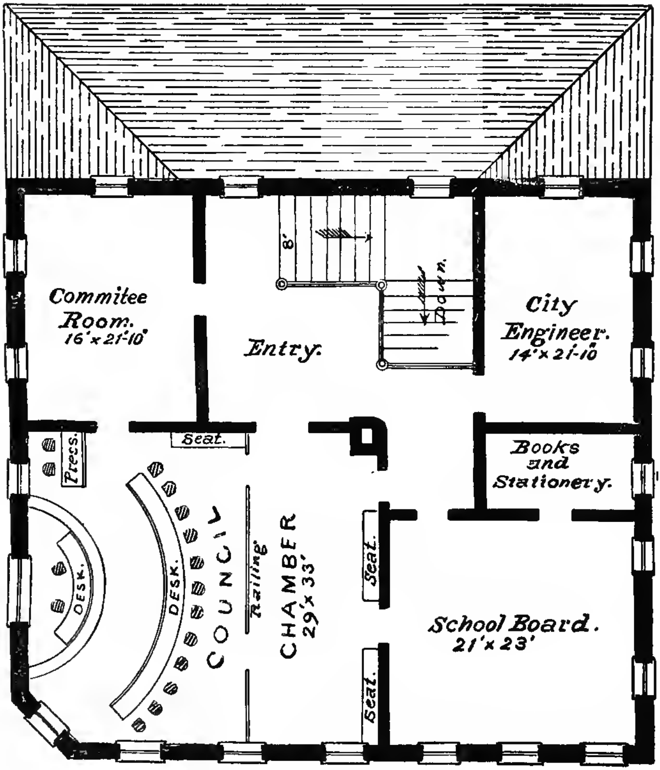
railing forms a lobby in both rooms in which the public can transact business with the occupants.

The chief of police or marshal has an office on the ground floor, near the main entrance; as an officer for emergencies he is therefore located where he can be reached easily and quickly. The marshal's duties are quite in common with those of the "superintendent of the poor," or the person who has charge of public or municipal charities: for this reason the rooms of these two officials adjoin.

In the rear of the Poor office is the water-closet, and beyond it the policemen's room, from which the patrolmen come and go as their duties require. This room has a side entrance, presumably from the alley, through which arrested persons may be taken to the lockup without passing through the building. The location of the water-closet, as shown, makes it convenient of access by all the occupants of the building, and for the police to take when necessary those who are confined in the lockup. From the police-room is a door to the basement stairway convenient for the janitor. The lockup adjoins the police-room, and is designed for temporary lodgment only; it is provided with bunks which should be iron cots, and the bedding should be blankets, and cotton ticks filled with straw, and pillows of the same materials. The blankets should be washed often, and the ticks and pillows, with contents, should be burned as often as necessary. The windows of the lockup should be at least seven feet from the floor, and barred upon the



GROUND PLAN—FRONT.



SECOND FLOOR—FRONT.

outside. There is no basement under the lockup floor; the area inside the walls is filled with gravel to within six inches of the floor level, and upon this are placed slabs of stone six inches thick, which serves as a floor; ventilation should be provided at the ceiling. The floor of the hose-carriage room is presumably about two feet lower than the office floor of the hall. There is no basement underneath this room nor under the stable adjoining; the floors are on a level with the grade of the sidewalk, and are made of two thicknesses of surfaced plank, laid crosswise of each other upon a gravel filling, the same as described for the lockup floor; or a cement floor may be laid.

The stalls in the stable are planned the same as those in general use where the doors are opened by electrical power; no mangers are provided, the animals being fed from boxes placed before them, or, as is most commonly done, the feed is dumped upon the floor at the head of the stall. The place for hay storage is sufficiently large where baled or pressed hay is fed; this may be built with 4 × 4 inch posts and the outside sheeted with No. 26 galvanized iron and then painted; all that is necessary is to protect the hay from sparks of fire and from pilferers. The paved court, if roofed, makes a convenient place to groom the horses. It is presumed the city has a water-works system, and only a two-horse hose-carriage need be kept in the building; larger accommodations for stabling horses will be necessary if both a steam fire-engine and hose cart are kept in the building. It may be observed

that no communication exists, within the hall, between the office part of the building and that portion occupied by the fire department; consequently no odors from the stable are communicated to the offices. If it is necessary to place a heating-stove in the hose-carriage room, another flue may be added to the chimney, although it is designed to heat the building either by hot air or steam, from a boiler or furnace in the basement.

The main hall is eight feet wide, and leads direct from the main entrance to the stairway, which is of the same width. The stairway should be of easy ascent, not more than seven-inch risers and about fourteen inches tread. The entry at the head of the stairway is commodious and well lighted.

The council chamber has a wide entrance—doors to be double, and to swing either way. The chamber is 29 × 33 feet, and ample for a council composed of fourteen aldermen. It is well lighted, having six windows; the large window shown above the mayor's desk should be placed at least eight feet above the floor, and the glass should be either colored or opaque, so as not to affect the eyesight of the aldermen who may sit facing it. The location of this window affords a good position for placing an historical window of colored glass, relating to some past event in the history of the city. The chamber should have a hardwood floor, and the walls should be wainscoted to a height of about four feet upon all sides.

The school board has a room adjacent to the council-

chamber; a window-lighted closet connects with this room, where books and school supplies may be kept under lock.

The committee-room, connecting with the council-chamber, can be used as a mayor's office if desirable. The city engineer's office is convenient of access and well lighted.

The lower floor of the hall should have its ceiling fourteen feet high; the upper floor may be the same if additional height can be had in the roof over the council-chamber—the ceiling of the chamber should be fifteen feet high. If the ceiling of the lower floor is made fourteen feet high, that of the hose-carriage room will be about sixteen feet. There is no economy in making ceilings very high: they do not afford any better facilities for ventilation than of moderate height; besides, more expense is incurred in heating rooms with lofty ceilings. Ventilation for the council-chamber may be had through walls and roof, if provided for in the plans.

The extreme dimensions of the hall are 54×60 feet. The rear addition is 16×60 feet if we include the court. The building is presumed to stand at a street corner, detached from other structures.

The ground area occupied by the building includes 4328 square feet. It can be built for about $12,000, which includes heating apparatus, plumbing, and sewer connections.

It is designed to be of brick, with stone door and window sills, water table, and porch columns. Roof to

be slated. Hardwood floors in hallway and entry; stairs of the same material. Provide ventilation for the vaults by means of iron pipes, about three inches in diameter, which may be removed when the vaults have dried out and the openings then filled with good concrete. It is almost impossible to make a vault (such as are shown in the plan, for the clerk and treasurer) dry out in a year's time so that it can be used, unless ventilation is provided.

CLEANLINESS AND PUBLIC HEALTH.

WE of this generation are lectured more on the sub ject of cleanliness as conducive to public health than on almost any other matter which relates to public affairs. Yet our towns and cities are not kept in a cleanly condition; indeed, there are few municipalities which do not put forth supreme efforts, annually, to eradicate or abate some epidemic that is increasing the death-rate of the community above the average, and the cause of this increased mortality can in most cases be traced directly to a neglect of proper sanitation.

The cleanliness of cities is an enforced, not a voluntary, condition. Every city has upon record laws and ordinances sufficient, which if properly enforced, would leave nothing to be said or written upon this subject; but filthy conditions exist because such laws are not enforced, and only in our larger cities is any serious attempt made to make people cleanly according to the requirements of sanitary laws and regulations.

The cleanliness of a city, if made clean at all, must be obtained through the efforts of a board of health, a body of medical men appointed specially for the purpose of enforcing such sanitary laws and regulations as are by charter provided; but if these medical

men, in the exercise of their duties as health officers, attempt to carry out the sanitary requirements of the law, involving an expense to the individual and the city, they will surely draw upon themselves a great deal of censure and personal dislike. The average individual seems to consider personal conditions as personal prerogatives, and therefore resents most emphatically any insinuations regarding the filthiness of his person or premises. If by the filthiness of his premises sickness is caused in his household, he will not hesitate to call a physician to meet the patient; but if that physician, as a health officer, have previously called upon the householder and warned him to remove the existing cause of the illness, the probabilities are that the physician will be unceremoniously ordered off the premises, nor will he afterwards be called to treat the patient. This should not be considered an exceptional instance, for every bureau officer connected with a city government knows how far he can go in the discharge of his duties and retain his popularity; when this is gone his displacement is sure to follow.

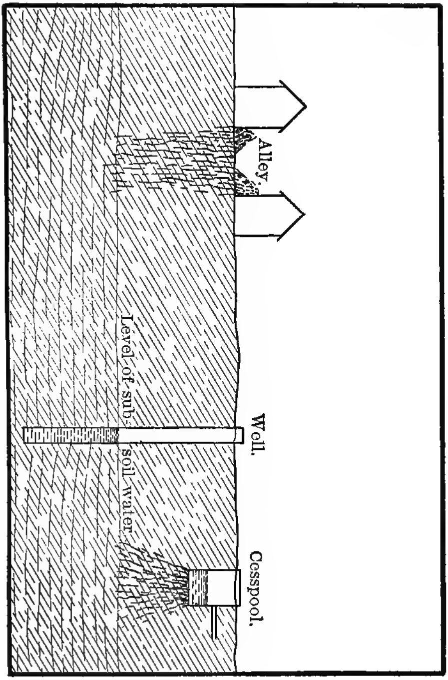
The general public are apt to confound hygienic regulations with sumptuary laws and do not clearly note the difference; hence the unpopularity of an officer which oftentimes results from the enforcement of sanitary laws.

Some years ago it was a mooted question among scientists whether disease is produced by filth alone or by filth and some particular poison. Of late years

Liebermeister's opinion is gaining ground: that filth is the favorable nest (*nidus*) for disease to find conditions favorable to a rapid development, and a potent auxiliary to filth in the spreading of disease is dampness. The Massachusetts Board of Health says, in one of its reports: "The most widespread evil in our State brought out by these investigations is dampness of soil arising from incomplete drainage." This conclusion was arrived at after a series of long-continued and exhaustive investigations to find and locate causes which led to the outbreak of typhoid fever and other diseases.

We need no better sanitary laws and regulations than now exist in nearly all cities, but they do need a more efficient and intelligent recognition from the individual, and the general public through its representatives, the common council. If such laws were enforced one half as rigidly as the same laws are in the forts and encampments of the army, there would be much less to complain of in this matter of municipal cleanliness. There is no good reason why a city should not be as cleanly as the ground occupied by troops where the need of it is equally as great, if not greater; for a city has a large population of the young and the helpless to protect and care for. The Union troops which occupied the city of New Orleans during the civil war made that city so clean that no epidemics occurred there until after the government of the city reverted to its civil rulers.

It is undoubtedly true that the uncleanness of


Alley.
Level of sub-soil water.
Well.
Cesspool.

towns and cities is the cause of most of the diseases which prevail within them. The diseases prevalent from this cause are small-pox, measles, scarlet fever, diphtheria, croup, typhoid fever, diarrhœa, cholera morbus and dysentery, consumption and pneumonia. The detailed causes of the appearance of such diseases are: bad or no ventilation, overcrowded habitations, a polluted surface and subsoil, bad drainage or none at all, neglect of vaccination, of isolation and disinfection, the presence of filth and the use of impure water in the household.

The purity of the water used has much to do with the healthfulness of a community, and the greatest care should be exercised to obtain a wholesome water which should be proven so by analysis. All water obtained from wells located within a municipality should be rejected for use in the household and the wells filled up, for very few will bear the test of purity. True, the average citizen will almost always defend the purity of the water from the well located upon his premises; he may say that he has drunk that water for twenty or perhaps forty years and he is quite certain of its purity. At the same time he forgets that the population about him has in the meantime increased perhaps an hundred-fold, and the now inhabited watershed which supplies that well with water is not the cleanly slope it was—all those years the population has steadily contributed to its pollution.

The water in such a well may be clear, sparkling, and palatable. The sparkle is due largely to the presence

of carbonic acid gas; and if some of the water is put into a bottle and placed where it will be warm, it will soon indicate its bad qualities by a putrid condition and offensive smell.

The vaults of all privies within towns and cities should be built water-tight. It is better that they should always be built so, whether in the city or country, for the farmer is not always particular regarding the juxtaposition of privy and well.

Where sewerage is provided the outdoor privy is generally dispensed with, but where it remains in use the vault should be built as previously stated, because it is essential to the healthfulness of a community that the area of ground upon which it lives and exists should be undefiled, that causes for its pollution should not be allowed to exist. In wet seasons, when cellars are made damp or are flooded with storm-water surcharged more or less with the pollution of the soil through which it percolates into the cellar, the future danger from disease in the household has its beginning. It does not follow that because the cellar has a connection with the street sewer to drain off the inflow, there will be an exemption from illness in the household; it is quite the reverse. For the sewer-drain removes only the flowing water and leaves the cellar damp, retaining all the impurities of the soil brought into it by the influx of the water. If storm-water is allowed to stand in puddles on the street, it will surely find its way into adjacent cellars if the soil is at all porous.

Parents are often inclined to charge the public school with the cause of illness of their children. Inferentially they are correct in doing so, for the public schools assist in the dissemination of diseases, but it is rarely that a disease originates within them. More often the disease which has an outbreak in the school comes from some household wherein the sanitary conditions are bad, and the children have carried its results into the school-room.

During the late war, after a regiment had encamped upon a plot of ground for several weeks, its commander would remove the regiment elsewhere, and the camp would then be made upon new and fresher ground, because the old camp-ground had become uncleanly and in a condition which made it a menace to the health of the troops encamped upon it. Yet there are hundreds of towns and small cities in this country which have been camping-grounds for the denizens thereof for a great many years, and they have neither moved to more cleanly and fresher sites nor have they done anything to make existing conditions more cleanly and healthful. The truth plainly told is that the average citizen of the smaller towns and cities has rather a contemptuous opinion of sanitation in all its branches, and is also inclined to consider the relations between filth and disease as being something mythological.

The occasional cholera "scares" which sweep this country are the best incentives to municipal and private cleanliness that we have. One scare such as we

had in 1892 did more to alarm and awaken the public to the needs of general sanitation, and cause immediate and active efforts towards cleanliness, than all the lectures and publications which have been uttered upon this question during the past quarter of a century.

If we are inclined to believe that the particular city in which we live is a cleanly one, all we have to do to prove or to disprove the fact is to make an exploration of the alleys and back-yards within it. It is not necessary to relate what sorts of filth may be found, nor speak of the general condition of the alleys and back-yards thus explored, but it is quite safe to say that few of us can make such an investigation and afterwards say that we live in a city which is thoroughly clean.

The writer was told more than once that a heap of manure which remained piled in an alley some length of time was not at all detrimental to healthful conditions, because, it was said, it contained so little moisture—never enough to make a rill, however small; yet directly above the heap was the eave of a barn, without a gutter; and all the rainfall from that slope of the roof fell on and about the heap, carrying with it into the earth its share towards the pollution of the soil of the city. In many places it is hardly thought worth the while to grade alleys and provide them with gutters, because they are so little travelled; consequently the rainfall, instead of washing its surface clean, makes pools of water in all the de-

pressions, and its subsequent absorption carries all the impurities into the earth with it.

Garbage should always be deposited in water-tight receptacles and thence regularly emptied and the contents carted away. Manure, carcasses of dead animals, small as well as large, dead poultry and all such refuse should be removed daily from the precincts of a city and either buried or burned; the dumping of such matter into living waters should be prohibited by a general law.

The piles of boxes, barrels, refuse timber, and other such material generally found in back-yards are not conducive to healthful surroundings; they not only retain dampness and become affected with partial decay, but they cover the ground and keep it damp, when every foot of unoccupied ground about the premises should be exposed to all the air and sunshine that can favor it. Decaying vegetable matter in back yards will produce miasmatic conditions as well as if it were in a swamp, with a partial advantage in favor of the swamp during those seasons of the year when it is overflowed with water, the decay being arrested by the submergence. Casting kitchen slops upon the premises should never be allowed by a householder. They contain a great deal of objectionable matter and is one of the most difficult fluids to dispose of by earth absorption that we have, and one of the most difficult to cleanse of its impurities. Few persons can conceive, without examination, how very foul a plot of earth will become that has been the dumping-place for

kitchen slops for a considerable length of time. If the soil is at all porous, this sort of pollution will affect the earth many feet below the surface.

It is difficult to prevent the use of cesspools on private grounds, but every cesspool in use contributes to the unhealthfulness of a community, inasmuch as it contributes to the general pollution of the subsoil.

Individual effort employed at intervals will not keep a city clean; the combined efforts of all are required: if one man keeps his premises clean and his neighbor does not, both are likely to suffer from the latter's neglect. Perhaps no other condition in life in which man is placed exemplifies so well the old adage "that one man is another man's keeper" as in this one question of municipal cleanliness, when a neighbor having filthy premises may cause disease and death in one's household.

The statistics of the cholera epidemic which prevailed in London in 1854 show that where people used water conveyed through pipes from a pure supply the deaths were 37 to 10,000, and among those who used water from wells and cisterns the deaths were 130 to 10,000. Sixty-six per cent greater mortality among those who drank impure water! This is cited to show how thoroughly the subsoil of a city can become polluted and the inhabitants not realize to what extent the danger exists.

Ice will contain germs of disease if taken from waters affected by the decomposition of vegetation; this is often done under the belief that the water from

which the ice was formed is strictly pure. Freezing water does not destroy the germs of disease it may contain, although freezing may cause them to be inoperative, as it were, until placed in warmer conditions when used in the household. Therefore a city should, as a part of its hygienic duties, exercise some oversight regarding the source of the ice supplied to its inhabitants.

In all towns and cities there exist people who are not cleanly either of person or premises; a great many who have come here from abroad are not cleanly either by training or instinct, and their number is so large and they congregate under such unwholesome conditions in our cities that they should receive special attention until they become habituated to a cleaner life. There are others also who are uncleanly in their person and surroundings who do not live in poverty nor in overcrowded tenement-houses. Squalor and poverty are terms generally used to describe the poor of cities, yet there are many poor people who are as neat and cleanly in all respects as can be found: squalor and laziness are more often the conditions which go together, and where found the sanitary laws should be rigorously applied, for it is from such people that epidemics spread among our schools.

The health officer cannot very well compel cleanliness in a household, nor can he investigate the condition of private cellars previous to the outbreak of a disease. We can only surmise from external appearances that filthy conditions exist there, and we must

await results before an inspection of the premises will be tolerated. But we can compel cleanliness of clothes and person of the children sent to school from such habitations, and this is a matter which should be rigidly observed by all school boards. Some of them have already taken hold of this question of cleanliness of pupils and in a commendable manner, and public opinion should strengthen the hands of the school commissioner in this work, by giving him an unqualified support. As a hygienic writer has truly said, rear the children to habits of cleanliness and the result is a greater self-respect and a higher view of man's general condition, which leads them to revolt against filth and disease as they become older.

Sewage disposal is another important question which the denizens of all cities, not already having done so, will be called upon to solve. The great increase of population of this country during the past twenty-five years is shown quite conclusively, if in no other way, by the general adoption of sewerage systems even by incorporated villages as well as cities. Ten years hence the sewer connections in these towns and cities will be quite extensively made, and all those modern appurtenances of the household which collect and convey filth to the public sewer will be in almost general use, and the daily outpouring of sewage will then be so great that the question of sewage disposal will of itself arise,—and it can be *downed* only in one way, and that way must lead to a purifying process of some kind. Those cities located remote from tide-water

will be the first to care for their sewage which has been for years polluting some river, lake, or pond. We are quite content, as a general rule, to turn our sewage into such living waters, and excuse ourselves with the plea that it is but temporary; yet it is a fact that we do not abate the nuisance until an outside (outside the corporate limits) influence and pressure compels such abatement; and it is this outside pressure of public opinion which will sooner or later compel a majority of our cities to take care of their sewage in a manner that will not be offensive nor objectionable to the residents of adjoining towns.

Man is naturally gregarious, and what with "booms," bonuses to manufacturing plants, and the construction of suburban motor lines of railway, he is forcing this natural instinct to a greater development than was ever known before. By this means our cities are growing larger in area, and the populations becoming more condensed, and the question of sanitation follows closely at the heels of this rapid material development. The population is on the ground, its work of pollution has begun; for how long a community will fight against diphtheria, scarlet fever, and other zymotic diseases before it will, as a body, act to remove the causes, will depend largely upon the mortality within it.

The safe requirements for a community to observe and enforce to promote its healthfulness are: clean streets, alleys, and private grounds; a well-drained subsoil and dry cellars; the daily removal of all garbage; a water supply of known purity; good ventila-

tion in schools, halls of assemblage, and in its homes, and the observance of personal cleanliness in all conditions of life. We may not all be inclined to believe that these conditions are strictly essential to the general good health of a community, but we might give them the benefit of the doubt, and take care that the truth does not come to us through bitter experience.